1509/1163

PHYSICO-THEOLOGY:

DEMONSTRATION

OF THE

Being and Attributes of GOD,

Works of Creation.

Being the SUBSTANCE of

Sixteen SERMONS

Preached in St. Mary-le-Bow-Church, LONDON;

At the Honourable Mr. BOYLE's LECTURES, in the Years 1711, and 1712.

With large Notes, & many curious Observations.

By W. DERHAM, Canon of Windsor, Rector of Upminster in Essex, and F.R.S.

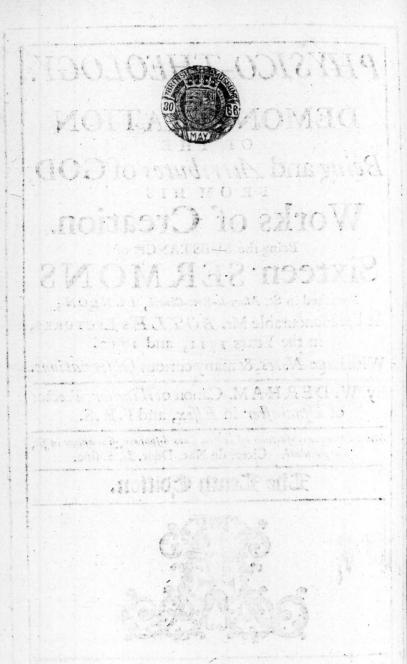
Mala & impra consuetudo est contra Deos disputare, sive animo id sit, sive simulate. Cicer. de Nat. Deor. L. 2. sine.

The Tenth Edition.



London Printed, and Re-printed in Dublin: By and for SAMUEL FAIRBROTHER, Bookfeller, and are to be Sold at his Shop in Skinner-Row, opposite the Thodel, 1730.

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Most Reverend Father in GOD,

THOMAS,

Lord Archbishop of CANTERBURY; Primate of all ENGLAND, &c.

The Surviving TRUSTEE of the Honourable Mr. BOYLE's LECTURES.

May it please Your GRACE,



May justly put these LECTURES under Your Grace's Patronages their Publication being wholly owing to You: For having the Honour to be a Member of The Royal

Society, as well as a Divine, I was minded to try what I could do towards the Im-A 2 prove-

The DEDICATION.

provement of Philosophical Matters to Theological Uses; and accordingly laid a Scheme of what I have here Published a Part of, and when I had little else to do, I drew up what I had to say, making it rather the diverting Exercises of my Leisure Hours, than more serious Theological Studies. This Work, (although I made a considerable Progress in it at first, whilst a Novelty, yet) having no Thoughts of Publishing, I laid aside, until your Grace, being informed of my Design by some of my Learned Friends, both of the Clerry and Laity, was pleased to call me to the unexpetted Honour of Preaching Mr. Boyle's Lectures: An Honour I was little aware of in my Country-Privacy, and not much acquainted with Persons in High Stations, and not at all, particularly, with Your Grace. So that therefore as it pleased Your Grace, not only to confer an unfought profitable Honour upon me (a Stranger,) but also to continue it for Two Years, out of Your good Opinion of my Performance, in some Measure, answering Mr. Boyle's End; so I can do no less than make this publick, grateful Acknowledgment of Your Grace's Great and Unexpetted Favour.

But it is not my self alone; but the whole Lecture also is beholden to your Grace's kind and pious Endeavours. It was You that encouraged this Noble Charity, and assisted in the Settlement of it, in the Honourable Founder's Life-time; and since his Death, it was You that procured a more certain Salary for the

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the Lecturers, paid more constantly and duly than it was before*.

These Benefits, as I my self have been a Sharer of, so I should be very ungrateful, should I not duly acknowledge, and repay with my repeated Thanks and good Wishes.

* It may not only gratify the Reader's Curiofity, but also be of Use for preventing Encroachments in Time to come, to give the following Account of Mr. Boyle's Lectures.

Mr. Boyle, by a Codicil, dated July the 28th, 1691, and annexed to his Will, charged his Messuage, or Dwelling-House, in St. Michael's Crooked-Lane, London, with the Payment of the clear Yearly Rents and Profits thereof, to some Learned Divine in London, or within the Bills of Mortality, to be Elected for a Term not exceeding Three Years, by his Grace the present Lord Archbishop of Canterbury (then Dr. Tennison) Sir Henry Asburst, Sir John Rotheram, and John Evelyn, Esq. The Business he appointed those Lectures for, was, among others, To be ready to satisfy real Scruples, and to answer such new Objections and Difficulties, as might be started, to which good Answers had not been made. And also, To Preach Eight Sermons in the Year, viz, the first Monday of January, February, March, April, and May; and of September, October, and November. The Subject of these Sermons was to be. The Proof of the Christian Religion against Notorious Infidels, viz, Atheists. Theifts, Pagans, Fews, and Makometans; not descending lower to any Controversies that are among Christians themselves. But by Reason the Lecturers were seldom continued above a Year. and that the House sometimes stood empty, and Tenants brake, or failed in due Payment of their Rent, therefore the Salary fometimes remained long unpaid, or could not be gotten without some Difficulty: To remedy which Inconvenience, his present Grace of Canterbury procured a Yearly Stipend of 501. to be paid Quarterly for Ever, charged upon a Farm in the Parish of Brill, in the County of Bucks: Which Stipend is accordingly very duly paid, when demanded, without Fee or Reward.

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The DEDICATION.

And that the Infinite Rewarder of well-doing, may give Your Grace a plentiful Reward of these, and Your many other, both Publick and Private Benefactions, is the hearty Wish of

Your GR ACE's

Most Humble and Thankful

Son and Servant,

W. Derham.



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TO THE

READER.

SESSESSESSESSES +SESSES ESSESSESSES



S the noble Founder of the LEC-TURES I have had the Honour of Preaching, was a great Improver of Natural Knowledge, so, in all Probability, he did it out of a Pious End, as well as in Pursuit of

his Genius. For it was his settled Opinion, that nothing tended more to cultivate True Religion and Piety in a Man's Mind, than a thorough Skill in Philosophy. And such Effect it manifestly had in him, as is evident from divers of his published Pieces; from his constant De-

portment in never mentioning Funeral Serm. p. 24.

Pause, and visible Stop in his Discourse; and from the noble Foundation of his Lectures for the Honour of GOD, and the generous Stipend he allowed for the same.

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And

And forafmuch as his Lectures were appointed by him for the Proof of the Chri-Vid. Mr. Boyle's stian Religion against Atheists Will. and other notorious Infidels, I thought, when I had the Honour to be made his Lecturer, that I could not better come up to his Intent, than to attempt a Demonstration of the Being and Attributes of GOD, in what I may call Mr. Boyle's own, that is a Physico-Theological Way. And, besides that it was for this yery Service that I was called to this Honour, I was the more induced to follow this Method, by Reason none of my learned and ingenious Predecessors in these Lectures, have done it on purpose, but only casually, in a transient, piece-meal Manner; they having made it their Business to prove the great Points of Christianity in another Way, which they have accordingly admirably done. But confidering what our Honourable Founder's Opinion was of Natural Knowledge, and that his Intent was, that those Matters, by passing through divers Hands, and by being treated of in different Methods, should take in most of what could be faid upon the Subject; I hope my Performance may be acceptable, although one of the Meanest.

As for others, who have before me done something of this kind; as Mersenne on Genesis; Dr. Cockburne in his Estays; Mr. Ray in his Wisdom of God, &c. and I may add the first of Mr. Boyle's Lecturers, the most learned Dr. Bentley, in his Boyle's Lectures, the eloquent Archbishop of Cambray, (and I hear, the ingenious Monsieur Perault hath something of this Kind, but never faw

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faw it:) I fay, as to these learned and ingenious Authors, as the Creation is an ample Subject, for I industriously endeavoured to avoid doing over what they before had done; and for that Reason did not, for many Years, read their Books until I had finished my own. But when I came to compare what each of us had done, I found my felf in many Things to have been anticipated by some or other of them, especially by my Friend, the late great Mr. Ray. And therefore in some Places Ishorten'd my Discourse, and referr'd to them; and in a few others, where the Thread of my Difcourse would have been interrupted, I have made use of their Authority, as the best Judges; as of Mr. Ray's, for Instance, with Relation to the Mountains and their Plants, and other Products. If then the Reader should meet with any Thing mentioned before by others, and not accordingly acknowledged by me, I hope he will candidly think me no Plagiary, because I can assure him I have all along, (where I was aware of it,) cited my Authors with their due Praise. And it is scarce possible, when Men write on the same, or a Subject near a-kin, and the Observations are obvious, but that they must often hit upon the same Thing: And frequently this may happen from Persons making Observations about one, and the fame Thing, without knowing what each other hath done; which indeed, when the first Edition of my Book was nearly printed off, I found to be my own Case, having (for want of Dr. Hook's Micrography being at hand, it being a very scarce Book, and many Years since I read it,) given Descriptions of two or three Things, which

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I thought had not been tolerably well observ'd before, but are describ'd well by that curious Gentleman.

One is a Feather, the Mechanism of which we in the main agree in, except in his Representation in Fig. 1. Scheme 22. which is somewhat different from what I have represented in my Fig. 18, &c. But I can stand by the Truth, though not the Elegance of my Figures. But as to the other Differences, they are accidental, oceasion'd by our taking the Parts in a different View, or in a different Part of a Vane; and to fay the Truth, (not flattering my felf, or detracting from the admirable Observations of that Great Man,) I have hit upon a few Things that escap'd him, being enabled to do fo, not only by the Help of fuch Microscopes as he made use of; but also by those made by Mr. Wilson, which exceed all I ever saw, whether of English, Dutch, or Italian Make ; several of which Sorts I have seen and examined.

The other Thing we have both of us figur'd and describ'd, is, The Sting of a Bee or Wasp; in which we differ more than in the last. But by a careful Re-examination, I find, that although Dr. Hook's Observations are more Critical than any where before, yet they are not fo true as mine. For as to the Scabbard, (as he calls it,) I could never discover any Beards thereon; and I dare be confident there are none, but what are on the two Spears. And as to the Point of the Scabbard, he hath represented it as tubular, or bluntish at the

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Top: but it really terminates in a sharp Point, and the two Spears and the Poison came out at a Slit, or longish Hole, a little below the Top or Point. And as to the Spears, he makes them to be but one, and that the Point thereof lies always out of the Scabbard. But by a strict Examination, they will be found to be two, as I have faid, and that they always lie within the Scabbard, except in stinging; as I have represented them, in Fig. 21. from the transparent Sting of a Wasp. And as to the Spear being made of Joints, and parted into two, as his Fig. 2. Scheme 16. represents, I could never upon a Review, discover it to be fo, but imagine, that by feeing the Beards lying upon, or behind the Spears, he might take them for Joynts, and by feeing the Point of one Spear lie before the other, he might think the Spear was parted in two. But lest the Reader should think himself imposed upon both by Dr. Hook, and my Self, it is necessary to be observ'd, that the Beards (or Tenterbooks, as Dr. Hook calls them) lie only on one Side of each Spear, not all round them; and are therefore not to be feen, unless they are laid in a due Posture in the Microscope, viz. side-ways, not under, or a-top the Spear,

The last Thing, (which scarce deserves mention) is the Mechanism of the Hair, which Dr. Hook found to be solid, like a long Piece of Horn, not hollow, as Malpighi found it in some Animals. And I have found both those Great Mento be in some Measure in the Right, the Hair of some Animals, or in some Parts of the Body, be-

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ing very little, if at all, tubular; and in others, particularly *Mice*, *Rats*, and *Cats*, to be as I have represented in my *Fig.* 14, &c.

And now if my Inadvertency in other Things hath no worse Effect than it hath had in these, namely, to confirm, correct, or clear others Obfervations, I hope the Reader will excuse it, if he meets with any more of the like kind. But not being conscious of any such Thing, (although probably there be many fuch) I am more follicitous to beg the Reader's Candour and Favour, with Relation both to the Text and Notes: In the former of which, I fear he will think I have as much under-done, as in the latter over-done, the Matter: But for my Excuse, I desire it may be confider'd, That the textual Part being Sermons, to be deliver'd in the Pulpit, it was necesfary to infift but briefly upon many of the Works of GOD, and to leave out many Things that might have been admitted in a more free Difcourse. So that I wish it may not be thought I have faid too much rather than too little for such an Occasion and Place. And indeed, I had no fmall Trouble in expunging fome Things, altering many, and foftening the most, and, in a Word, giving in some Measure the Whole a different Dress than what I had at first drawn it up in, and what it now appears in.

And as for the *Notes*, which may be thought too large, I confess, I might have shorten'd them, and had Thoughts of doing it, by casting some of them into the Text, as an ingenious, learned Friend

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Friend advis'd. But when I began to do this, I found it was in a Manner to new-make all, and that I should be necessitated to transcribe the greatest Part of the Book, which (having no Assistant) would have been too tedious for me, being pretty well fatigu'd with it before. I then thought it best to pare off from some, and to leave out others. and accordingly did fo in many Places, and would have done it in more, particularly in many of the Citations out of the Ancients, both Poets and others, as also in many of the Anatomical Obfervations, and many of my own and others Obfervations: But then I confidered, as to the First, that those Citations do (many of them at least) thew the Sense of Mankind about GOD's Works, and that the most of them may be acceptable to young Gentlemen at the Universities, for whose Service these Lectures are greatly intended. And as to the Anatomial Notes, and some others of the like Nature, Habst of them serve either to the Confirmation, or the Illustration, or Explication of the Text, if not to the learned, yet to the unskilful, less learned Reader; for whose Sake, if I had added more, I believe he would forgive me. And laftly, as to the Observations of my self, and some others, where it happens that they are long, it is commonly where a Necessity, lay upon me of fully expressing the Author's Sense, or my own, or where the: Thing was new, and never before Publish'd; in which Case, it was necessary to be more Express and Particular, than in Matters better known, or where the Author may be referr'd unto.

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In the former Editions I promised another Part I Had relating to the Heavens, if I was thereunto encourag'd. And two large Impressions of this Book, having been sold off, so as to admit of a Third before the Year was gone about; and hearing that it is translated into two, if not three Languages; but especially being importuned by divers Learned Persons, both known and unknown, I have thought my self sufficiently engaged to persorm that Promise; and have accordingly Published that Part.

So that I have now carry'd my Survey through most Parts of the visible Creation, except the Waters, which are for the most Part omitted; and the Vegetables, which, for want of Time, I was forced to treat of in a perfunctory Manner. to the Undertaking of the former of these, having receiv'd divers Sollicitations from Persons unknown, as well as known, I think my felf bound in Civility to own their Favour, and to return them my hearty Thanks for the kind Opinion they have shewn of my other Performances, that they have encourag'd me to undertake this other Task. And accordingly I have begun it, and (as far as my Affairs will permit) have made some Progress in it: But Age and Avocations growing upon me, I begin to fear I shall scarce be able to finish it as I would, and therefore must recommend that ample and noble Subject to others, who have more Leifure, and would do it better than I.

As to Additions, I have been much follicited thereto by divers curious and learned Persons, who would

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would have had me to infert some of their Observations, and many more of my own: But in a Work of this Nature, this would have been Endless; and although the Book would thereby be render'd much better, and more compleat, yet I could by no Means excuse so great an Injustice to the Purchasers of the former Editions. And therefore (except in the second Edition, where it was not easy to be avoided) few Additions or Alterations have been made, besides what were Typographical, or of small Consideration. Only in the third Edition I amended the first Paragraph of Note 1. Chap. 5. Book 1. concerning Gravity; and in the Fourth, Page 16, and 18, I inserted two Passages out of Seneca, that were inadvertently left out, and corrected many Things, that upon a careful Review, feem'd to want Amendment.

And lastly, as to the following Analysis, it was added at the Request of some of my learned and ingenious Friends; and although it might have been contracted, they would not suffer it to be so.





OF THE

Following Book.

HE Works of the Creation relating to our Terraqueous Globe, are fuch as are visible in the

[Outworks or Appendages of the Globe, viz. thefe Threes 1. The Atmosphere

Composed of Air and Vapours, Page 4.

Useful to

Respiration and Animal Life, ibid.

Vegetation of Plants 9.

Conveyance of

The winged Tribes. Sound 11.

The Functions of Nature.

Reflecting and Refracting Light 12.

Containing the

(Winds, which are of great Use and Necessity To the Salubrity and Pleasure of the Air 14.

In various Engines 18.

(In Navigation.

Clouds and Rain: Of great Use to the

Refreshment of the Earth and the Things there-

Origine of Fountains, according to fome 23.

2. Light. Its

Fountain 26. Wonderful Necessity and Use.

Improvement by Glasses 28.

Velocity.

Expansion 29.

3. Gravity.

S Its great Benefit 33.

Caufe of Levity, which is of great Use in the

World 34. I Terraqueous Globe it self. Of which I take a View in

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If General of. (Its Spherical Figure, which is the most commodious in regard of, Light 40. Heat. Lodgment of the Waters. The Winds 41. Its Bulk 43. Its Motion, ibid, 5 Annual. Diurnal. Its Place and Distance from the Sun, and other Heavenly Bodies 46. Its Diffribution, so as to cause all the Parts of the Globe to Balance each other 48. Be helpful to one another. The great Variety and Quantity of all Things ferving for Food, Physick, Building, and every Use and Occasion of all Ages, Places, and Creatures 54. An Objection answered 55. Particular of the Earth; of its [Constituent Parts, viz. Its Soils and Moulds, necessary to the Growth of various Vegetables 62. Various Occasions of Man, and other Animals 62: Various Strata or Beds, affording Materials for Tools. Firing. Building. Dying, and thousands of other Things 66. Conveyance of the fweet Fountain-Waters ibid. Subterraneous Caverns and Vulcano's; of great Use to Countries where they are 69. Mountains & Valleys, which are not rude Ruins, but Works of Defign, inafmuch as this Structure of the Earth is The most beautiful and Pleasant. The most Salubrious: to some Constitutions, the Hills; to fome, the Valleys 73. Best to skreen us, and other Things 74. Beneficial to the C Production of various Vegetables. Harbour and Maintenance of various Animals 75, Generation of Minerals and Metals 76. Absolutely necessary to the Conveyance of the Rivers; and in all Probability to the Origine of Fountains 80. Conclusion against blaming GOD 87. Its Inhabitants; which are either Senfitive or Infenfitive. 6. Concerning the Senfitive.

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Sensitive, some Things are Common to all the Tribes, particularly these Ten: I. The five Senses and their Organs; the 87. Eye, an admirable Piece of Mechanism in regard of its Form, for the most part Spherical, which is best for the Reception of Objects. Motion of the Eye 92. Situation in the most commodious Part of the Body of every Creature. Motion, in some Animals, Severy Way.
Fixed; and the excellent Provision in that Case 93.
Size; which is in All Creatures, according to their Occasions. Such as live Abroad in the Light, larger. Such as live under Ground, less. Number, in some Animals: Two 96 More: Together with the wise Provision to prevent double Vision.
Parts; fome of which are viewed Transiently, the Arteries, Veins, and some of the Muscles and Tunicks. More strictly some of the Muscles, and the excellent Provision made for their peculiar Uses, Equilibration, &c., 99. Tunicks: Among which the various Aper-
tures, Forms, and Positions of the Pupil are particularly noted 101. Humours, especially the prodigious Finery and Composition of the Crystalline, ac-
cording to Mr. Lewenboeck, Nerves 108. Soptick.
Covering of the Eye-Lids. Strong and curious Bones. Hard and firm Tunicks. Withdrawing them into their Heads 112. Of Erect Vision 114. Hearing. Its
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Organ, the Ear 115. Double, enabling us to hear every Way, and a good Provision for the Loss or Hurt of one: Situated in the very best Place for Information; Security, and near the Eye and Brain. The Fabrick of the Outward Ear, which is in All Creatures formed, guarded, placed, and every way accoutered according to their various Places and Occasions 118. Man fuitable to his erect Posture; and all its Parts, the Helix, Tragus, Concha, &c. admirably fuited to the Reception and Melioration of Sounds, and the Security of the Part. Inward Ear: In which I take a View of the 122 Auditory Paffage, curiously tunnelled, tortuous, and smooth; and being always open, is lined with the naufeous Ear-wax for a Guard. Tuba Eustachiana 124. Bone, particularly hard and context for Guard and to affift the Sound. Tympanum, and its Membrane, Muscles, and four little Bones to correspond to all Kinds of Sound. Labyrinth, Semicircular Canals, Cochlea; all made with the utmost Art 129. Auditory Nerves, one of which is ramified to the Eye, Tongue, Muscles of the Ear, and to the Heart; whence a great Sympathy between those Parts 131. Object, Sound. Under which I confider, The Improvements thereof by the Wit of Man 132 Its great Necessity, and excellent Uses 135. (Its Pleasure, and the Power of Musick 137. Smelling. In which Sense these Things are remarkable, the Nostrils, always open, cartilaginous, and endowed with Muscles 139. Laminæ, ferving for A Guard against noxious Things 141. The spreading of the Olfactory Nerves. Prodigious Use of it in all, especially some of the Irrationals 142. Tafte. The Things most remarkable in which Sense are, the Nerves spread about the Tongue and Mouth, with their Guard.

The Papillæ, neatly made 143.
Situation thereof to be a Centinel to the Stomach and Food.

Confent thereof with the other Senses, by some Branches of the fifth Pair 144.

Feeling 145.

Whose Organ is the Nerves ibid.

Which is dispersed through every Part of the Body, and the admirable Benefit thereof.

II. Respiration the grand Act of Animal Life 147.

[Ministering to the Circulation of the Blood and Diaflole of the Heart.

The Parts concerned therein are

The Larynx, with its great Variety of Muscles, &. for Respiration, and forming the Voice 151.

Trachea and Epiglottis, exquisitely contrived and made.

Bronchi and Lungs, with their curious Arteries,

Veins and Nerves 153.

Ribs, Diaphragm, and the feveral Muscles concern'd,

Its Defects in the

Fœtus in the Womb 156. Amphibious Creatures 157. Some Animals in Winter.

III. The Motion of Animals: Concerning which I confider
[Transiently the

Muscles, and their Structure, their Size, Fastening to the Joynts, Motions, &c. 160.

Bones, and their curious Make 162.

Joynts, with their Form, Bandage and Lubricity 164.

Nerves, and their Origine, Ramifications and Inofculations.

More particularly the Loco-Motive Act itself, which is Swift or flow, with Wings, Legs many or few, or none at all, according to the various Occasions and Ways of Animals Lives. As particularly in

Reptiles, whose Food and Habitation is near at hand. Man and Quadrupeds, whose Occasions require a larger Range, and therefore a swifter Motion 166.

Birds, and Infects, whose Food, Habitation and Safety require yet a larger Range, and have accordingly a yet swifter Motion and direct Conveyance. Geometrically & neatly performed by the nicest Rules.

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Due Equipoise of the Body 168. Motive Parts being accurately placed with regard to the Center of the Body's Gravity, and to undergo their due Proportion of Weight and Exercise. IV. The Place allotted to the several Tribes of Animals to Live and Act in. Concerning which I observe that Their Organs are adapted to their Place 170. All Places habitable are duly stocked. Various Animals have their various Places; and the Wildom thereof 171. V. The Balance of Animals Numbers, fo that the World Overstocked by their Increase. Depopulated by their Death. Which is effected in The feveral Tribes of Animals by a due Proportion in the Length of their Life 172. Number of their Young, in Ufeful Creatures being many. Pernicious few. Man very remarkable by the Different Length of his Life. Soon after the Creation 174. When the World was more, but not fully Peopled 175. When it was fufficiently flocked, down to the prefent Time. Due Proportions of Marriages, Births and Burials 177 Balance of Males and Females 178. VI. The Food of Animals. In which the Divine Management and Providence appears in the 183. Maintaining fuch large Numbers of all Kinds of Animals on the Land, in the Seas, and divers Places too unlikely to afford fufficient Food. Adjustment of the Quantity of Food to the Number of Devourers, fo that There is not too much, fo as to rot, and annoy the World 185. The most Usefulis the most Plentiful, and easiest Propagated ibid. Delight which the various Tribes of Animals have to the Varieties of Food, so that what is grateful to one, is nauseous to another : Which is a wife Means to cause All Creatures to be fufficiently supplied. All forts of Food to be confumed. The World to be kept sweet and clean by those Pc-Means 187.

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Peculiar Food, that particular Places afford to the Creatures residing therein 188.

Curious Apparatus in all Animals for Gathering, and Digestion of their Food, viz. the

Mouth, nicely shaped for Food, &c. In

Some, little and narrow 193. Some, with a large deep Incifure.

Infects very notable to catch, hold and devour Prey; to carry Burdens, to bore and build their Habitations 194.

Birds as notable, Horned in all. In some Hooked for Rapine, climbing, &c. 196. Sharp and strong to pierce Trees, &c.

Long and slender to grope.

Long and broad to quaffer.
Thick and sharp edged to husk Grain.
Compressed to raise Limpets, &c.

Teeth, which are peculiarly hard, firmly inferted in the Jaws, variously shaped in the same, and different Animals, deficient young Greatures, &c. 200 Salival Glands, commodiously placed for Mastica-

tion and Deglutition ibid.

Muscles and Tendons, serving to Mastication, strong and well lodged.

Gullet, fized according to the Food; with curious Fibres, &c. 201.

Stomach, 202.

Which hath a curious Mechanism of Fibres, Tunicks, Glands, Nerves, Arteries and Veins. Whose Faculty of Digestion by such seeming weak

Menstruums is admirable.

Whose Size and Strength is conformable to the Nature of the Food, or Occasions of Animals. Which is in

Tame Animals but one.

Ruminants, Birds, &c. more.

Guts, whose Tunicks, Glands, Fibres, Valves, and Peristaltick Motion deserve Admiration 205.

Lacteals, together with the Impregnations from the Pancreas, Gall, Glands, and Lymphæducts.

Sagacity of all Animals in finding out, and providing Food. In

Man less remarkable for the sake of his Understanding 207.

Inferiour Creatures. In fuch as are

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Come to mature Age, and are able to help themselves. by their Accurate Smell 208. Natural Craft. Hunting and groping out of Sight. Seeing and Smelling at great Distances 210. Climbing; the strong Tendons and Muscles acting therein. Seeing in the dark. Helpless. As 212. Young Creatures Man, born the most helpless of any, the Parents Reason, Hands, and Affection sufficing. Irrationals: For whose Young the Creator hath made a fufficient Provision, partly by the Parent-Animals own Erogyi, and Diligence in Nurfing and Defending them 212. Sagacity and Care in repositing their Eggs and Young, where Food and all Necessaries are to be found 214. Ability of the Young themselves to shift for, and help themselves, with the little Helps of their Dams 215. Creatures destitute of Food at some Seasons, or likely to want it, who Are able to live long without Food 216. Lay up Food before-hand. VII. The Cloathing of Animals, which is 219. Suited to the Place and Occasions of all. In Man it is left to his own Reason and Art, joined with fufficient Materials: Which is best for him. Because he may fute his Cloathing to his Quality and Business 224. For Perspiration and Health fake, To exercise his Art and Industry. To excite his Diligence in keeping himself sweet and clean, In being the Parent of divers Callings 225. Irrationals: Who are either Ready furnished with proper Cloathing. On the dry Land with Hair, Fleeces, Furs, Shells, hard Skins, &c. 226. In the the Air with Feathers, light, ffrong and warm. In the Waters with Scales, hard for Guard; fmooth

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for Paffage; or with strong Shells to guard such as move more flowly 229. Provide for themselves by their Textrine, or Architechtonick Art. Of which under the next Branch. Well garnished, being all Workman-like, compleat, in its Kind beautiful, being ibid. C Adorned with gay, various and elegant Colours. If fordid, yet with exact Symmetry, and full of curious Mechanism. VIII. The Houses and Habitations of Man, who is abundantly furnished with Contrivance and Art to build and garnish his Habitations 231. (Materials of all forts to effect his Works. CIrrationals, whose marvellous Instinct is manifested by the Convenience of their Nests and Habitations for the Hatching and Education of their Young 234. Guard and Defence of themselves and their Young, Fabrick of their Nests, scarce imitable by Man, and shewn by their Contrivance and Make, being exactly fuitable to their Occasions, and made by Putting only a few ugly Sticks, Moss, Dirt, &c. together 237. Building Combs according to the best Rules of Mathematicks Weaving Webs, and making Cases. For which Service the Parts of their Bodies, and Materials afforded by them are very confiderable. IX. Animals Self-Preservation. For which there is always a Guard in proportion to the Dangers and Occasions of their State. Which is observable in (Man, whose Reason and Art supplies the Defect of Natural Armature. Irrational Creatures: who As they are on one Handfufficiently guarded bytheir Shells, Horns, Claws, Stings, 80c. 245. Changing their Colours. Wings, Feet, and Swiftness. Diving in, and tinging the Waters. Ejecting Juices out of their Body. Accurate Smell, Sight, and Hearing. Natural Craft 249. Uncouth Noise, ugly Gesticulations, and horrid Aspect.

Horrible Stink and Excrements.

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So on the other Hand can by their Strength, Sagacity, or natural Artifices entrap and captivate what is necessary for their Food and other Occasions.

X. Animals Generation.

¿ Equivocal, is denied 251.

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Man, is sumesmeas i sua, passed wholly by

Irrational Creatures, which is remarkable for their Sagacity in chufing the fittest Place for their Eggs

and Young: Where it is observable what a Compleat Order they observe.

Neat Apparatus their Bodies are provided with

for this Purpose. 253.

Natural Venom they inject with their Eggs into Vegetables to pervert Nature, and produce Balls and Cases 256.

Making Use of the fittest Seasons, either

All Seasons 257.

When Provisions are most plentiful and easiest had.

Due Number of Young 258.

Diligence and Concern for their Young, in point of

S Incubation 259.

Safety and Defence 260.

Faculty of Nursing their Young, by Suckling them. In which it is observable

How fuitable this Food is.

How willingly parted with by all, even the most savage What a compleat Apparatus in all Creatures of

Dugs, &c. Putting Food in their Mouths, with their proper Parts

for catching and conveying Food 262.

(Neitherway, but bylaying in Provisions before-hand. 263

Having in the Fourth Book thus dispatched the Decad of Things in common to the Sensitive Creatures, I take 2 View of their particular Tribes, viz. of

[Man; whom I consider with relation to his

Soul. Concerning which, having curforily mentioned divers Things, I infift upon two as shewing an espe-

cial Divine Management, the

Various Genii, or Inclinations of Men, which is a wife Provision for the Dispatch for all the World's Affairs, and that they may be performed with Pleasure 269.

Inventive Faculty. In which it is remarkable that

Its Compass is so large, extending to all Things of Use, and occasioning so many several Callings. Things of greatest Necessity and Use were soon and easily found out; but Things less Useful later, and dangerous Things not yet. Here of divers particular Inventions, with an Exhortation to exercise and improve our Gifts. Body. In which the Things particularly remarked upon are the Erect Posture 289. The most convenient for a Rational Being. Manifestly intended, as appears from the Structure of some particular Parts mentioned 292. Nice Structure of the Parts ministring thereto. Equilibration of all the Parts 293. Figure and Shape of Man's Body most agreeable to his Place and Bufiness 294, Stature and Size, which is much the best for Man's State 295. Structure of the Parts, which are Without Botches and Blunders. Of due Strength. Of the best Form, Most accurately accommodated to their proper Offices. Lodgment of the Parts, as the Five Senses 304. Hand. Legs and Feet. Heart. Viscera. Several Bones and Muscles, &c. 305. Covering of all with the Skin. Provision in Man's Body to Prevent Evils by the (Situation of the Eyes, Ears, Tongue & Hand. 307 Guardafforded all, especially the principal Parts. Duplication of fome Parts. Cure of Evils by means of Proper Emunctories 308. Discases themselves making Discharges of Things more dangerous 310. Pain giving Warning, and exciting our Endeavours. Consent of the Parts, effected by the Nerves, a Sam0

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ple whereof is given in the Fifth Pair, branched to the Eye, Ear, &c. (Political, fociable State. For the Preservation and Security of which the Creator hath taken Care by Variety of Mens CFaces 315. Voices. (Hand-Writing. Quadrupeds. Of which I take no Notice, but wherein they differ from Man, viz. Prone Posture, which is confiderable for The Parts ministring to it, especially the Legs and Feet, fized and made in some for Strength and flow Motion 322, Agility and Swiftness. Walking and Running. Walking and Swimming. Walking and Flying. Walking and Digging. Traverfing the Plains. Traverfing Ice, Mountains, &c. Its Usefulness to (Gather Food 324. Catch Prey. Climb, Leap and Swim. Guard themselves. Carry Burdens, Till the Ground, and other Uses for Man. Parts differing from those of Man. Head, wherein I confider Its Shape, commonly agreeable to the Animal's Motion 325. The Brain, which is, Leffer than in Man 326.
Placed lower than the Cerebellum. The Nictitating Membrane 327. Carotid Arteries, and Rete Mirabile. Nates. Neck. S Answering the Length of the Legs 329. Strengthened by the Whitleather. Stomach 330. Corresponding to the several Species. Suited to their proper Food, whether Flesh, Grain, &c. Heart : Its Ventricles

Ventricles in some One only 331. Two. Three, as fome think. Situation nearer the midst of the Body, than in Man. Want of the Fastening of the Pericardium to the Midriff 333. Nervous Kinds. A Sample of which is given in the different Correspondence between the Head and Heart of Man and Beaft, by the Means of the Nerves 335. Birds. Concerning which I take a View of their Body and Motion; where I confider The Parts concerned in their Motion 339. The Shape of the Body, made exactly for swimming in, and paffing through the Air. Feathers, which are Most exactly made for Lightness and Strength. All well placed in every Part, for the Covering and Motion of the Body. Preened and dreffed 340. Wings, which are Made of the very best Materials, viz. of Bones, light and strong; Foynts exactly opening, shutting, and moving, as the Occasions of Flight require; and the Pettoral Muscles, of the greateft Strength of any in the whole Body. Placed in the nicest Point of the Body of every Species, according to the Occasions of Flight, Swimming or Diving. Tail, which is well made, and placed to keep the Body steady, and affist in its Ascents and Descents. 343. Legs and Feet, which are made light for Flight, and incomparably accoutered for their proper Occasions of Swimming 344, Walking, Catching Prey. Roofting. Hanging. Wading and Searching the Waters. Lifting them upon their Wings. Motion it felf. S Performed by the nicest Laws of Mechanicks. Answering every Purpose and Occasion, Other Parts of the Body, viz. the Head, [xiv]

Head, remarkable for the commodious
Shape of it felf 346,
Forms of the Bill.
Site of the Eye and Ears.
Position of the Brain.
Structure of the

SLarynx.
Tongue.

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Provision by Nerves in the Bill for tasting and distinguishing Food 350.

Stomachs, one to

Macerate and prepare 351.

Crind and digeft.

Lungs incomparably made for

S Respiration ibid.

Making the Body buoyant.

Neck, which is made

In due Proportion to the Legs.
To fearch in the Waters, and
To counterpoise the Body in Flight.

State. Of which I take Notice of three Things, wiz.

Migration remarkable for

The Knowledge Birds have of Their Times of Passage 354. The Places proper for them.

Their Accommodation for long Flights by long or else strong Wings.

Incubation, which is confiderable for

The Egg, and its Parts 357.

Act it felf; that these Creatures should betake themselves to it, know this to be the Way to produce their Young, and with Delight and Patience sit such a due Number of Days.

The Neglect of it in any, as the Offrich, and the wonderful Provision for the Young in that

Case 360. Nidification. Of which before.

Insects. Which altho' a despised Tribe, doth in some Respects more set forth the Infinite Power and Wisdom of the Creator, than the larger Animals.

The Things in this Tribe remarked upon are their

Body 365.

Shaped, not so much for long Flights, as for their Food, and Condition of Life.

Built not with Bones, but with what ferves both for Bones and Covering too. Eyes,

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Eyes, reticulated to fee all Ways at once 367. Antennæ, and their Use ibid. Legs and Feet made for Creeping 369. Swimming and Walking. Hanging on fmooth Surfaces. Leaping. Digging. Spinning and Weaving Webs and Cafes. Wings, which are Nicely distended with Bones 371. Some incomparably adorned with Feathers and elegant Colours. Some joynted and folded up in their Elytra, and diffended again at Pleasure. In Number either Two, with Poises. Four, without Poifes. Surprizing Minuteness of some of those Animals themselves, especially of their Parts, which are as numerous and various as in other Animal Bodies 373 State: which fets forth a particular Concurrence of the Divine Providence, in the wife and careful Provision that is made for their Security against Winter, by their Subfifting in a different, viz. their Nympha or Aurelia State 376. Living in Torpitude, without any Waste of Body or Spirits ibid. Laying up Provision before-hand. Preservation of their Species by their Chufing proper Places, to lay up their Eggs and Sperm. fo that the Eggs may have due Incubation 380.
Young fufficient Food. Care and Curiofity in repositing their Eggs in neat Order, and with the proper Part uppermost 388. Incomparable Art of Nidification, by being endow'd Parts proper for, and agreeable to the several Ways of Nidification, and the Materials they use in it. Architectonick Sagacity to build and weave their Cells, or to make even Nature herself their Handmaid 391.

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Reptiles.

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Reptiles. Which agreeing with other Animals in something or other before treated of, I confider only their Motion, which is very remarkable, whether we confider the

(Manner of it, as

Vermicular 400.

Sinuous.

Snail-like.

Caterpillar-like.

Multipedous.

Parts ministring to it. Parts ministring to it. Scourge Man's Wickedness 404.

Their easie Capture and Mastery of their Prey. Their Digestion. Watery Inhabitants confiderable for their Great Variety 407. Prodigious Multitudes. Vast Bulk of some, and surprizing Minuteness of o-Incomparable Contrivance and Structure of their Bodies. andre V stall by The Supplies of Food. Respiration. Adjustment of their Organs of Vision to their Element. Poise and Motion of the Body every Way 408. Infensitive Inhabitants. Among which having mentioned Fossils and others, I insist only upon Vegetables, and that in a curfory Manner upon their Great Variety for the several Uses of the World 410 Anatomy. Leaves 412. Flowers, and their admirable Gaiety. Seed, remarkable for its Generation. Make. Containing in it a compleat Plant 414. Preservation and Safety in the Gems, Fruit, Earth, &c. Sowing, which is provided for by Down, Wings, Springy Cases, carried about by Birds, sown by the Husbandman, &c. 418. Growing and Standing: Some by (Their own Strength 423. The Help of others, by clasping about, or hanging upon them. Remarkable Use, especially of some which seem to be provided for the Good of

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S All Places 425.

Some particular Places, to

Supply fome Local Wants.

Practical Inferences upon the Whole are these Six, viz.
That GOD's Works

1. Are Great and Excellent 430.

2. Ought to be enquired into, with a Commendation of fuch as do fo 432.

3. Are manifest to all, and therefore Atheism unreasonable 433.

4. Ought to excite Fear and Obedience 436.

5. Ought to excite Thankfulness 438.
6. Should move us to pay God his due Homages and Worship, particularly that of the Lord's Day: which is an Appointment

The most Ancient 444.

Wisely contrived for Dispatch of Business, and to prevent Carnality.

Whose proper Business is, to cease from Worldly, and to follow Spiritual Employments; the Chief of which is the Publick Worship of GOD.

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Terraqueous Globe.

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N Pfal. cxi. 2. The Psalmist asserts, That the (a) Works of the Lord are great; fought out of all them that have Pleafure therein. This is true of all God's Works, particularly of his Works of Creation: Which when fought out: or, as the Hebrew Word (b) signisieth, when heedfully and deeply pried into, folicitously observed and enquired out, especially when clearly discovered

⁽a) It is not unlikely that the Psalmist might mean, at least have an Eye to, the Works of the Creation in this Text, the Word, which is manifestly applied to the Works of Creation, and properly fignifieth Fastum, Opus, Opissium, from Post Paravit, Aptavit. And saith Kircher, Significat talem affectionem, qua aliquid existit vel realiter, vel ernate, vel ut non sit in pristino statu quo suit. Concord. p. 2. col. 931.

⁽b) BTT Quafivit, perquifivit, sciscitatus est. Buxtor. in verb. Et simul importat curam, & solicitudinem. Conrad. Kirch. ib. P. 1. col. 1174.

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to us; in this Case, I say, we find those Works of God abundantly to deserve the Pfalmist's Character of being Great and Noble; inasmuch, as they are made with the most exquisite Art, (c) contrived with the utmost Sagacity, and ordered with plain wise Design, and ministring to admirable Ends. For which reason St. Paul might well affirm of those noisuata of God, (d) That the invisible Things of God, even his eternal Power and Godbead, are understood by them. And indeed they are the most easy, and intelligible Demonstrations of the Being and Attributes of God; (e) especial-

(d) And a little before he faith of Nature it felf, Omnem

ergo rigit Naturam ipse [Deus] &c.

(e) Mundus codex est Dei, in quo jugiter legere debemus. Bernard.

Arb tror nullam gentem, neque Hominum societatem, apud quos ulla Deorum est religio, quidquam habere sacris Eleusiniis aut Samothraciis simile: Ea tamen obscure docent que prostientur: Nature verò opera in omnibus animantibus sunt perspicua. Galen. de Us. Part. 1. 17. c. 1.



⁽c) Quod si omnes mundi partes ita constituta sunt, ut neque ad usum meliores potuerint esse, neque ad speciem pulchriores; videamus utrum es fortuita sint, an eo statu, quo cobarere nullo medo potuerint, nisi sensu moderante divinaque providentia. Si ergo meliora sunt ea que Natura. quam illa, que Arte perfecta sunt, nec Ars efficit quid sine ratione; ne Natura quidem rationis expers est habenda. Qui igitur convenit signum, aut tabulam pictam cum adspexeris, scire adhibitam esse artem; cumque procul cursum navigii videris, non dubitare, quin id ratione atque arte moveatur : aut cum Solarium, &c. Mundum autem, qui & bas ipsas artes. & earum artifices. & cuntta complectatur, consilii & rationis esse expertem putare? Quid si in Scythiam, aut in Britanniam, Spharam aliquis tulerit hanc, quam nuper familiaris noster effecit Posidonius cujus singula conversiones idem efficient in Sole, &c.__ efficitur in colo singulis diebus & noctibus; quis in illa barbarie dubitet, quin ea Sphara sit perfecta Ratione? Hi autem dubitant de Mundo, ex quo & oriuntur, & fiunt omnia, casune ipse sit effectus, - an Ratione, an Mente divina? Et Archimedem arbitrantur plus valuisse in imitandis Sphara conversionibus, quam Naturam in efficiendis prasertim cum multis partibus sint illa perfecta, quam bec simulata, solertius, &c. Cic. de Nat. 1. 2. c. 34, 35.

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ly to such as are unacquainted with the Subtilties of Reason and Argumentation; as the greatest Part of Mankind are.

It may not therefore be unsuitable to the Nature and Design of Lectures (f) founded by one of the greatest Vertuoso's of the last Age, and instituted too on Purpose for the Proof of the Christian Religion against Atheists, and other Insidels, to improve this Occasion in the Demonstration of the Being and Attributes of an infinitely wise and powerful Creator, from a Cursory Survey of the Works of Creation, or [as often called] of Nature.

Which Works belong either to our Terraqueous Globe, or the Heavens.

I shall begin with our own Globe, being nearest, and falling most under our Senses. Which being a Subject very various and copious, for the more methodical and orderly proceeding upon it, I shall distribute the Works therein:

I. Into fuch as are not properly Parts, but Appendages of Out-works of the Globe.

II. The Globe it felf.

(f) Philosophia est Catechismus ad Fidem. Cyril. 1. contr. Jul.



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BOOKI

Of the Out-Works of the Terraqueous Globe; the Atmosphere, Light, and Gravity.

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CHAP. I. Of the Atmosphere in General.

HE Atmosphere, or Mass of Air, Vapours and Clouds, which surrounds our Globe, will appear to be a Matter of Design, and the infinitely wise Creator's Work, if we consider its Nature and Make (a), and its Use to the World (b).

tile penetrating Matter, fit to pervade other Bodies, to penetrate into the inmost Recesses of Nature, to excite, animate, and spiritualize; and in short, to be the very Soul of this lower World. A

Thing consequently,

2. Of greatest Use to the World, useful to the Life, the Health, the Comfort, the Pleasure, and Business of the Whole Globe. It is the Air the whole Animal World breatheth, and liveth by; not only the Animals inhabiting the Earth (c) and Air.

(a) Mundi pars est Aer, & quidem necessaria: Hicest enim qui calum terramque connectit, &c. Senec. Nat. Qu. l. 2. c. 4.

⁽b) Ipse Aer nobiscum videt, nobiscum audit, nobiscum sonat; nibis enim eorum sine eo steri potest, &c. Cic. de Nat. Deor. l. 2. c. 33.

⁽c) As the Air is of absolute Necessity to Animal Life, so it is necessary that it should be of a due Temperament or Con-

Confidence; not foul, by reason that suffocateth; not too rare and thin, because that sufficeth not; with Examples of each of which, I shall a little entertain the Reader. In one of Mr. Hawksbee's Compressing Engines, I closely shut up a Sparrow, without forcing any Air in; and in less than an Hour the Bird began to pant, and be concerned; and in less than an Hour and Half to be fick, vomit, and more out of Breath; and in two Hours time was nearly expiring.

Another I put in and compressed the Air, but the Engine leaking, I frequently renewed the Compressure; by which Means, (although the Bird panted a little after the first Hour,) yet after such frequent Compressures, and Immission of fresh Air, it was very little concerned, and taken out seem-

ingly unhurt after three Hours.

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After this I made two other Experiments in compressed Air, with the Weight of two Atmospheres injected, the Engine holding tight and well; the one with the Great-Titmouse, the other with a Sparrow. For near an Hour they seemed but little concerned; but after that grew fainter, and in two Hours time sick, and in three Hours time died. Another Thing I took Notice of, was, that when the Birds were sick, and very restless, I fancied they were somewhat relieved for a short Space, with the Motion of the Air, caused by their stuttering and shaking of their Wings, (a Thing worth trying in the Diving-Bell.) I shall leave the ingenious Reader to judge what the Cause was of both the Birds living longer incompressed, than uncompressed Air; whether a less Quantity of Air was not sooner souled and rendred unsit for Respiration, than a greater.

From these Experiments two Things are manifested; one is, that Air, in some measure compressed, or rather heavy, is necessary to Animal Life: Of which by and by. The other, that fresh Air is also necessary; for pent-up Air, when overcharged with the Vapours emitted out of the Animal's Body, becomes unfit for Respiration. For which Reason, in the Diving-Bell, after some time of stay under Water, they are torced to come up and take in fresh Air, or by some such Means recruit it. But the famous Cornelius Drebell contrived not only a Vessel to be rowed under Water, but also a Liquor to be carried in that Vessel, that would supply the want of fresh Air. The Vessel was made for King Fames I. It carried Twelve Rowers, besides the Passengers. It was tried in the River of Thames; and one of the Persons that was in that submarine Navigation was then alive, and told it one, who related the Matter to our famous Founder, the Honourable, and most Ingemous Mr. Boyle. As to the Liquor, Mr. Boyle faith, he discover-

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ed by a Doctor of Physick, who married Brebel's Daughter, that it was used from time to time when the Air, in the submarine Boat, was clogged by the Breath of the Company, and thereby made unsit for Respiration; at which time, by unstopping a Vessel full of this Liquor, he could speedily restore to the troubled Air such a Proportion of vital Parts, as would make it again for a good while sit for Respiration. The Secret of this Liquor Drebell would never disclose to above one Person, who himselfassured Mr. Boyle what it was Nade Boyle's Exp. Plys. Mech. of the Spring of the Air, Exp. 41. in the Digression. This Story I have related from Mr. Boyle, but at the same time much question, whether the Virtues of the Liquor

were so effectual as reported.

And as too gross, so too rare an Air is unfit for Respiration, Not to mention the forced Rarefactions made by the Air-Pump, in the following Note; it is found, that even the extraordinary natural Rarefactions, upon the tops of very high Hills, much affect Respiration. An Ecclesiastical Person, who had visited the high Mountains of Armenia, (on which some fancy the Ark rested) told Mr. Boyle, that whilst he was on the upper Part of them, he was forced to fetch his Breath oftner than he was wont: And taking Notice of it when he came down the People told him, that it was what happen'd to them when they were so high above the Plane, and that it was a common Observation among them. The like Observation the same Ecclesiastick made upon the top of a Mountain in the Cevennes, So a learned Traveller, and curious Person, on one of the highest Ridges of the Pyrenees, call'd Pic de Midi, found the Air not so fit for Respiration, as the common Air, but he and his Company were fain to breath shorter and oftner than in the lower Air. Vide Phil. Transact, No. 63. or Loguthorp's Abridg. Vol. 2, p. 226.

Such another Relation the learned Joseph Acosta gives of himself, and his Company, that, when they passed the high Mountains of Peru, which they call Periacaca, (to which he saith, the Alps themselves seemed to them but as ordinary Houses, in regard of high Towers,) He, and his Companions, were surprized with such extreme Panes of Straining and Vomiting, (not without casting up of Blood too,) and with so violent a Distemper, that he concludes he should undoubtedly have died; but that this lasted not above three or sour Hours, before they came into a more convenient and natural Temperature of the Air, All which he concludes, proceeded from the too great Subtilty and Delicacy of the Air, which is not proportionable to humane Respiration, which requires a more

gross and temperate Air, Vide Boyle, ubi supra,

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Thus it appears, that an Air too Subtile, Rare and Light; is unfit for Respiration: But the Cause is not the Subtilty, or too great Delicacy, as Mr. Boyle thinks, but the too great Lightness thereof, which renders it unable to be a Counterbalance, or an Antagonist to the Heart, and all the Muscles ministring to Respiration, and the Diastole of the Heart. Of

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which fee Book 4. Chap. 7. Note 1.

And as our Inability to live in too rare and light an Air. may discourage those vain Attempts of Flying, and Whimsies of passing to the Moon, &c. so our being able to bear an heavier State of the Air is an excellent Provision for Mens Occasions in Mines, and other great Depths of the Earth; and those other greater Pressures made upon the Air, in the Diving-Bell, when we descend into great Depths of the Waters.

(d) That the Inhabitants of the Air, (Birds and Infects,) need the Air as well as Man, and other Animals, is manifelt from their speedy dying in too feculent, or too much rarefied Air; of which fee the preceding and following Note f. But yet Birds and Infects (fome Birds at least) can live in a rairor Air than Man. Thus Eagles, Kites, Herons, and divers other Birds, that delight in high Flights, are not affected with the Rarity of the Medium, as those Persons were in the preceding Note. So Infects bear the Air-Pump long as in the following Note f.

(e) Creatures inhabiting the Waters need the Air, as well as other Animals, yea, and fresh Air too. The Hydrocanthari of all Sorts, the Nympha of Gnats, and many other Water-Infects, have a fingular Faculty, and an admirable Apparatus, to raise their back Parts to the top of the Waters, and take in fresh Air. It is pretty to see, for Instance, the Hydrocanthari come and thrust their Tails out of the Water, and take in a Bubble of Air, at the tip of their Vagina and Tails, and then nimbly carry it down with them into the Waters; and, when

that is spent, or fouled, to ascend again and recruit it. So Fishes also are well known to use Respiration, by pasfing the Water through their Mouths and Gills. But Carps will live out of the Water, only in the Air; as is manifest by the Experiment of their way of Fatting them in Holland, and which hath been practifed here in England, viz. they hang them up in a Cellar, or fome cool Place, in wet Mossina small Net, with their Heads out, and feed them with white Bread loaked in Milk, for many Days. This was told me by a Person very curious, and of great Honour and Eminence, whose

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it most Animals live scarce half a Minute (f); and others, that are the most accustomed to the want of it, live not without it many Days.

And

Word (if I had leave to name him) no Body would question: And it being an Instance of the Respiration of Fishes very singular, and somewhat out of the way, I have for the Rea-

der's Diversion taken notice of it.

(f) By Experiments I made my felf in the Air-Pump, in September and October, 1704, I observed that Animals whose Hearts have two Ventricles, and no Foramen Ovale, as Birds, Dogs, Cats, Rats, Mice, &c. die in less than half a Minute counting from the very first Exsuation; especially in a small Receiver.

A Mole (which I suspected might have born more than other Quadrupeds) died in one Minute (without Recovery) in a large Receiver; and doubtless would hardly have survived half a Minute in a small Receiver. A Bat (although wounded) sustained the Pump two Minutes, and Revived upon the re-admission of the Air. After that, he remained four Minutes and a half, and revived. Lastly, After he had been sive Minutes, he continued gasping for a Time, and after twenty Minutes I re-admitted the Air, but the Bat never revived.

As for Insects: Wasps, Bees, Hornets, Graspoppers, and Lady-Cows seemed dead in appearance in two Minutes, but revived in the open Air in two or three Hours time, notwithstanding

they had been in Vacuo twenty four Hours.

The Ear-wig, the great Staphylinus, the great black lowfy Beetle, and some other Insects would seem unconcerned at the Vacuum a good while, and lie as dead; but revive in the Air, although some had lain sixteen Hours in the exhausted Receiver.

Snails bear the Air-Pump prodigiously, especially those in Shells; two of which lay above twenty four Hours, and seemed not much affected. The same Snails I lest in twenty eight Hours more after a second Exhaustion, and sound one of

them quite dead, but the other revived.

Frogs and Toads bear the Pump long, especially the former. A large Toad, found in the House, died irrecoverable in less than six Hours. Another Toad and Frog I put in together, and the Toad was seemingly dead in two Hours, but the Frog just alive. After they had remained their eleven Hours, and seemingly dead, the Frog recovered in the open Air, only weak, but the Toad was quite dead. The same Frog being put in again for twenty seven Hours, then quite died.

The Animalcules in Pepper-water remained in Vacuo twenty four

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And not only Animals themselves, but even Trees and Plants, and the whole vegetable Race, owe their Vegetation and Life to this useful Element; as will appear when I come to speak of them, and is manifest from their Glory and Verdure in a free Air, and their becoming Pale and Sickly, and Languishing and Dying, when by any means excluded from it (g).

Thus useful, thus necessary, is the Air to the Life of the animated Creatures; and no less is it to the Motion and Conveyance of many of them. All the winged Tribes owe their Flight and Buoyancy (b) to it, as shall be shewn in proper Place: And even the watry Inhabitants themselves cannot

afcend

four Hours. And after they had been exposed a Day or two to the open Air, I found some of them dead, some alive.

(g) That the Air is the principal Cause of the Vegetation of Plants, Borelli proves, in his excellent Book De Mot, Animal. Vol. 2. Prop. 181. And in the next Proposition, he assured in Plantis quoque peragi Aeris respirationem quandam impersectam, a quad earum vita pendet, & conservatur. But of this more when I come to survey Vegetables.

Some Lettice-Seed being sown upon some Earth in the open Air, and some of the same Seed, at the same Time, upon other Earth in a Glass-Receiver of the Pneumatick Engine, afterwards exhausted of Air: The Seed exposed to the Air, was grown up an Inch and half high within Eight Days; but that in the exhausted Receiver not at all. And Air being again admitted into the same emptied Receiver, to see whether any of the Seed would then come up, it was found, that in the Space of one Week it was grown up to the Height of two or three Inches. Vide Phil. Trans. No. 23, Lowth, Abridg. Vol. 2, p. 206.

(b) In volucribus pulmones perforati aerem inspiratum in totam ventris cavitatem admittunt. Hujus ratio, ut propter corporis truncum dere repletum & quasi extensum, ipsa magis volatilia evadant, faciliusque ab Aere externo, propter intimi penum, sustententur. Equidem pisces, quò levius in aquis natent, in Abdomine vesicas Aere instatas gestant: pariter & volucres, propter corporis truncum Aere impletum quasi instatum, nudo Aeri incumbentes, minus gravantur, proindeque kvius & expeditius volant. Willis de Anim. Brut. p. 1. c. 3.

(i) Fiftes.

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ascend and descend into their Element, well withlants, and the whole vegetal (i) itiatuo

But it would be tedibus to descend too far into Particulars, to reckon up the many Benefits of this noble Appendage of our Globe in many useful En-

gines (k):

(i) Fishes, by reason of the Bladder of Air within them, can sustain or keep themselves in any Depth of Water: For the Air in that Bladder being more or less compressed, according to the Depth the Fish swims at takes up more or less Space; and consequently, the Body of the Fish, part of whose Bulk this Bladder is, is greater or less according to the several Depths, and yet retains the Same Weight. Now the Rule de Insidentibus humido is, That a Body that is heavier than fo much Water as is equal in Quantity to the Bulk of it, will fink, a Body that is lighter will swim; a Body of equal Weight will rest in any Part of the Water. By this Rule, if the Fist, in the middle Region of the Water, be of equal Weight to the Water, that is, commensurate to the Bulk of it, the Eish will rest there, without any Tendency upwards or downwards: And if the Fift be deeper in the Water the Bulk of the Fift becoming less by the Compression of the Bladder and yet retaining the same Weight, it will sink, and rest at the Bottom. And on the other Side if the Fift be higher than the middle Region the Air dilating it felf, and the Bulk of the Fife confequently increasing, but not the Weight the Fish will rife upwards and reft at the Top of the Water. Perhaps, the Fish by some Action can emit Air out of its Bladder ____, and, when not enough, take in Air, and then it will not be wondred, that there sould be always a fit Proportion of Air in all Fifes to serve their Use, &c. Then follows a Method of Mr. Boyle's to experiment the Truth of this. After which, in Mr. Lowthorp's Abridgment, follow Mr. Ray's Observations. I think thatbath hit upon the true Uje of the Swimming-Bladders in Fifes. For, 1. It bath been observed that if the Swimming-Bladder of any Fish be pricked or broken, fuch a Fish finks presently to the Bottom, and can neither Support or raise it self up in the Water. 2. Flat Fishes, as Soles, Plaife &c. which lie always grovelling at the Bottom, have no Swimming-Bladders that ever I could find. 3. In most Fises there is a manifest Chanel leading from the Gullet _____ to the said Bladder, which without doubt ferves for the conveying Air thereunto. ____In the Goat of this Bladder is a masculous Power to contract it when the Fift lifts. See more very curious Observations relating to this Matter, of the late great Mr. Ray, as also of the curious anonymous Gentleman, in the ingenious Mr. Lowthorp's Abridgment, before cited, p. 845. from Philosoph, Trans. No. 114, 115. (k) Among

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gines (k); in many of the Functions and Operations of Nature (l) in the Conveyance of Sounds; and a Thousand Things besides. And I shall but just mention the admirable Use of our Atmosphere in ministring to the enlightening of the World, by

(k) Among the Engines in which the Air is useful, Pumps may be accounted not contemptible ones, and divers other Hydraulical Engines, which need not to be particularly infifted on. In these the Water was imagined to rise by the Power of Suction, to avoid a Vacuum, and such unintelligible Stuff; but the justly samous Mr. Boyle was the first that solved these Phenomena by the Weight of the Atmosphere. His ingenious and curious Observations and Experiments relating here to, may be seen in his little Tract, Of the Cause of Annaction by Suction, and divers other of his Tracts.

(1) It would be endless to specify the Uses of the Air in Nature's Operations: I shall therefore, for a Sample only, name its great Use to the World in conserving animated Bodies, whether endowed with animal or vegetative Life; and its contrary Quality of diffolving other Bodies; by which Means many Bodies that would prove Nuisances to the World, are put out of the Way, by being reduced into their first Principles, (as we say,) and so embodied with the Earth again. Of its Faculty as a Menttruum, or its Power to diffolve Bodies; I may Instance in Crystal-Glasses, which, with long keeping. especially if not used, will in Time be reduced to a Powder, as I have feen. So divers Minerals, Earths, Stones, Fossil-Shells, Wood, &c. which from Noah's Flood, at least for many Ages, have lain under Ground, so secure from Corruption, that, on the contrary, they have been thereby made much the stronger, have in the open Air soon mouldred away. Of which last, Mr. Boyle gives an Instance (from the Differtation de admirandis Hungar. Aquis) of a great Oak, like a huge Beam, dug out of a Salt-Mine in Transylvania, so bard, that it would not easily be wrought upon by Iron Tools, yet, being exposed to the Air out of the Mine, it became so rotten that in four Days it was easy to be broken, and crumbled between one's Fingers. Boyle's Suspic. about iome hidden Qualities in the Air, p. 28. So the Trees turned out of the Earth by the Breaches at West-Thurrack and Dagenham, near me, although probably no other than Alder, and interred many Ages ago in a rotten oazy Mould, were to exceedingly tough, hard, and found at first, that I could

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(m); and refracting the Sun-beams to our Eye, before it ever furmounteth our Horizon (n); by which means the Day is protracted throughout the whole Globe; and the long and difmal Nights are shorten'd in the frigid Zones, and Day sooner approacheth

make but little Impressions on them with the Strokes of an Ax; but being exposed to the Air and Water, soon became so rotten as to be crumbled between the Fingers. See my

Observations in Philos Transatt. No. 335.

(m) By reflecting the Light of the beavenly Bodies to us, I mean that Whiteness or Lightness which is in the Air in the Day-Time, caused by the Rays of Light striking upon the Particles of the Atmosphere, as well as upon the Clouds above, and the other Objects beneath upon the Earth. To the fame Cause also we owe the Twilight, viz. to the Sun-beams touching the uppermost Particles of our Atmosphere, which they do when the Sun is about eighteen Degrees beneath the Horizon! And as the Beams reach more and more of the airy Particles, fo Darkness goes off, and Daylight comes on and encreafeth. For an Exemplification of this, the Experiment may ferve of transmitting a few Rays of the Sun through a small Hole into a dark Room : By which means the Rays which meet with Dust, and other Particles flying in the Air, are render'd visible; or (which amounts to the tame) those swimming small Bodies are rendered visible, by their reflecting the Light of the Sun-beams to the Eye, which, without fuch Reflection, would it felf be invisible.

The Azure Colour of the Sky Sir Isaac Newton attributes to Vapours beginning to condense, and that are not able to reflect the other Colours. V. Optic. 1. 2. Par. 3. Prop. 7.

(n) By the Refractive Power of the Air, the Sun, and the other heavenly Bodies feem higher than really they are, especially near the Horizon. What the Refractions amount unto, what Variations they have, and what Alterations in time they cause, may be briefly seen in a little Book called, The Arrificial Clock-Maker, Chap. 11.

Although this inflettive Quality of the Air be a great Incumbrance and Confusion of Astronomical Observations;——yet it is not without some considerable Benefit to Navigation; and indeed in some Cases the Benefit thereby obtained is much greater than would be the Benefit of baving the Ray proceed in an exact straight Line. [Then he men-

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mentions proacheth them; yea, the Sun it self riseth in Appearance (when really it is absent from them) to the great Comfort of those forlorn Places (0).

But passing by all these Things with only a bare mention, and wholly omitting others that might have been named, I shall only insist upon the excellent Use of this noble circumambient Companion of our Globe, in respect of two of its Meteors, the Winds, and the Clouds and Rain (p).

tions the Benefit hereof to the Polar Parts of the World.] But this by the by, (faith he.) The great Advantage I consider therein, is the first Discovery of Land upon the Sea; for by Means hereof, the Tops of Hills and Lands are raised up into the Air, so as to be discoverable several Leagues farther off on the Sea than they would be, were there no such Refraction, which is of great Benefit to Navigation for steering their Course in the Night, when they approach near Land; and likewise for directing them in the Day-time, much more certainly than the most exact Celestial Observations could do by the Help of an uninssected Ray, especially in such Places as they have no Soundings. [Then he proposes a Method to find, by these Means, the Distance of Objects at Sea.] Vide Dr. Hook's Post. Works. Lett. of Navig. p. 466.

(o) Cum Belga in nova Zembla bybernarent, Sol illis apparuit 16 diebus citius, quam revera in Horizonte existeret, boc est, cum adbuc infra Horizontem depressus esset quatuor circiter gradibus, & quidem

aere sereno. Varen. Geog. c. 19. Prop. 22.

[These Hollanders] found, that the Night in that Place shortened no less than a whole Month; which must needs be a very great Comfort to all such Places as live very far towards the North and South Poles, where Length of Night, and want of seeing the Sun, cannot chuse but he very tedious and irksome. Hook Ibid.

[By Means of the Refractions] we found the Sun to rife twenty Minutes before it sould; and in the Evening to remain above the Horizon twenty Minutes (or thereabouts) longer than it sould. Capt.

James's Journ, in Boyle of Cold. Tit. 18. p. 190.

(p) Aer—in Nubes cogitur: humoremque colligens terram auget imbribus: tum effluens buc & illuc, ventos efficit. Idem annuas frigorum cahorum facit varietates: idemque & volatus Alitum sustinet, & spiritu dustus alit & sustentat animantes. Cic. de Nat. Deor. 1. 2. c. 39.

CHAP. II. Of the Winds (a).

o pass by other Considerations, whereby I might demonstrate the Winds to be the Infinite Creator's Contrivance, I shall insist only upon their great Usefulness to the World. And forgreat is their Use, and of fuch absolute Necessity are they to the Salubrity of the Atmosphere, that all the World would be poisoned without those Agitations thereof. We find how putrid, fetid, and unfit for Respiration, as well as Health and Pleasure, a stagnating,

(a) Ventus eft aer fluens, is Seneca's Definition. Na. Qu. 1. 5. And as Wind is a Current of the Air, fo that which excites or alters its Currents, may be justly faid to be the Cause of the Winds. An Æquipoise of the Atmosphere produceth a Calm; but if that Æquipoise be more or less taken off, a Stream of Air, or Wind, is thereby accordingly produced either stronger or weaker, fwifter or flower. And divers Things there are that may make fuch Alterations in the Æquipoife or Balance of the Atmosphere, viz. Eruptions of Vapours from Sea or Land; Rarefactions and Condensations in one Place more than another; the falling of Rain, pressure of the Clouds, &c. Pliny 1. 2. c. 45. tells us of a certain Cavern in Dalmatia, called Senta, in quem, faith he, dejecto levi pondere, quamvis tranquillo die, turbini similis emicat procella. But as to Caves it is observed, that they often emit Winds more or less. Dr. Conner, taking notice of this Matter, specifies these, In regno Neapolitano ex immani Cumana Sibylla antro tenuem ventum effluentem percepi. The like he observed at the Caves at Baie, and in some of the Mines of Germany, and in the large Salt-Mines of Cracow in Poland. Ubi, faith he, opifices & ipse fodina dominus Andreas Mor-Sin, Nob. Polonus, mihi afferuerunt, quod tanta aliquando Ventorum tempestas ex ambagiosis bujus fodina recessibus surgere solebat, quod latorantes fossores humi prosternebat, nee non portas & domicilia (qua sibi in hac fodina artifices exstruunt) penitus evertebat. Bern. Connor. Differt. Med. Phys. p. 33. Artic. 3.

And as great Caves, fo great Lakes sometimes send forth Wands. So Gaffendus faith the Lacus Legnius doth, E quo dum

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stagnating, confined, pent-up Air is. And if the wholeMass of Air and Vapours was always at Rest, and without Motion, instead of refreshing and animating, it would suffocate and poison all the World:

exoritur fumus, nubes band dubie creanda est, qua sit brevi in tempestatem sevissimam exoneranda, Gassend. Vit. Peiresk. 1. 5. p. 417.

But the most universal and constant Alterations of the Balance of the Atmosphere, are from Heat and Cold. This is manifest in the General Trade-Winds, blowing all the Year between the Tropicks from East to West: if the Cause thereof be (as some ingenious Men imagine) the Sun's daily Progress round that Part of the Globe, and by his Heat rarefying one Part of the Air, whilst the cooler and heavier Air behind present after. So the Sea and Land Breezes in Noted. And to in our Climate, the Northerly and Southerly Winds (commonly effectmed the Causes of cold and warm Weather,) are really the Effects of the Cold or Warmth of the Atmosphere: Of which I have had fo many Confirmations, that I have no Doubt of it. As for instance, it is not uncommon to see a warm Southerly Wind, fuddenly changed to the North, by the fall of Snow or Hail; to fee the Wind in a frosty, cold Morning North, and when the Sun hath well warmed the Earth and Air, you may observe it to wheel about towards the Southerly Quarters; and again to turn Northerly or Easterly in the cold Evening. It is from hence also, That in Thunder-Showers the Wind and Clouds are oftentimes contrary to one another, (especially if Hail falls) the sultry Weather below directing the Wind one way; and the Cold above the Clouds another way. I took Notice upon March the 10th. 1710-11, (and divers fuch like Instances I have had before and fince) that the Morning was warm, and what Wind stirted was West-South-West, but the Clouds were thick and black (as generally they are when Snow enfues:) A little before Noon the Wind veered about to North by West, and fometimes to other Points, the Clouds at the fame time flying some North by West, some South-West: About One of the Clock it rained apace, the Clouds flying sometimes Northfast, then North, and at last both Wind and Clouds settled North by West; at which time Sleet fell plentifully, and it grew very cold. From all which I observe, 1. That altho our Region below was warm, the Region of the Clouds was cold, as the black, fnowy Clouds shewed, 2. That the struggie

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But the perpetual Commotions it receives from the Gales and Storms, keep it pure and healthful (b).

Neither are those Ventilations beneficial only to the Health, but to the Pleasure also of the Inhabitants of the Terraqueous Globe; witness the Gales which fan us in the Heat of Summer; without which, even in this our temperate Zone, Men are scarce able to perform the Labours of their Calling,

gle between the Warmth of ours, and the Cold of the cloudy Region, stopped the airy Currents of both Regions. 3. That the falling of the Snow through our warmer Air melted into Rainat first; but that it became Sleet after the Superiour Cold had conquered the inferiour Warmth, 4. That, as that Cold prevailed by Degrees, fo by Degrees it wheeled about both the Winds and Clouds from the Northwards towards the South,

Hippocrates, 1. 2. De Viet. Orat. Omnes Ventes vel à nive, glacie, vehementi gelu, fluminibus, &c. spirare necesse judicat. Bartholin.

de usu Nivis, c. 1.

(b) It is well-observed in my Lord Howard's Voyage to Constantinople, That at Vienna they have frequent Winds, which if they cease long in Summer, the Plague often ensues: So that it is now grown into a Proverb, That if Austria be not windy, it is subjett to Contagion. Bohun of Wind, p. 213.

From some such Commotions of the Air I imagine it is, that at Grand-Cairo the Plague immediately ceases, as soon as the Nile begins to overflow; although Mr. Boyle attributes it to nitrous Corpuscles. Determ, Nat. of Effluv. Chap. 4.

Nulla enim propemodum regio est, qua non habeat aliquem flatumen

fe nascentem. & circa se cadentem.

Inter catera itaque Providentia opera, boc quoque aliquis, ut dignum admiratione suspexerit. Non enim ex und causa Ventos aut invenit, aut per diversa disposuit : sed primum ut aera non sinerent pigrescere, sed assidua vexatione utilem redderent, vitalemque tracturis.

Nat. Quæst. 1. 5. c. 17, 18.

All this is more evident, from the Cause affigned to malignant epidemical Diseases, particularly the Plague, by my ingenious, learned Friend, Dr. Mead; and that is, an hot and moist Temperament of the Air, which is observed by Hippocrates, Galen, and the general Histories of Epidemical Difeafes, to attend those Diftempers. Vide Mead of Poisons, Estay 5. P. 161. But indeed, whether the Cause be this, or poison-

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or not without Danger of Health and Life (c). But especially, witness the perpetual Gales which throughout the whole Year do fan the Torrid Zone, and make that Climate an healthful and pleasant Habi-

ous, malignant Exhalations or Animalcules, as others think, the Winds are however very falutiferous in fuch Cases, in cooling the Air, and dispersing and driving away the moist or pestiferous Vapours.

(e) July 8. 1707. (called for some time after the Hot Tuefday,) was so excessively hot and suffocating, by reason there was no Wind stirring, that divers Persons died, or were in great Danger of Death, in their Harvest-Work. Particularly one who had sormerly been my Servant, a healthy, lusty, young Man, was killed by the Heat; and several Horses on the

Road dropped down and died the fame Day.

In the foregoing Notes, having Notice of some Things relating to Heat, although it be somewhat out of the way, I hope the Reader will excuse me, if I entertain him with some Observations I made about the Heat of the Air under the Line, compared with the Heat of our Bodies. F. Patrick, who, as he is very accurate in making Barometrical and Thermometrical Instruments, had the Curiofity for the nicer adjusting his Thermometers, to fend two abroad (under the Care of two very fensible ingenious Men) one to the Northern Lat. of 81; the other to the Parts under the Æquinoctial: In these two different Climates, the Places were marked where the Spirits stood at the severest Cold and greatest Heat. according to these Observations be graduates his Thermometers. With his Standard I compared my Standard Thermometer, from all the Degrees of Cold, I could make with Sal Armoviack, &c. to the greatest Degrees of Heat our Thermometers would reach to. And with the fame Thermometer (of mine) I experimented the greatest Heat of my Body, in July 1709. First in an hot Day without Exercise; by putting the Ball of my Thermometer under my Armpits, and other hottest parts of my Body. By which means the Spirits were raised 284 Tenths of an Inch above the Ball. that, in a much hotter Day, and indeed nearly as hot as any Day with us, and after I had heated my felf with strong Exercife too, as much as I could well bear, I again tried the fame Experiment, but could not get the Spirits above 288 Tenths; which I thought an inconfiderable Difference, for fo feemingly a very different Heat of my Body. But from forme Experi

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Habitation, which would otherwise be scarce habitable.

To these I might add many other great Conveniencies of the Winds in various Engines, and various Businesses. I might particularly insist upon its great Use to transport Men to the farthest distant Regions of the World; (d) and I might particularly speak of the general and coasting Trade-Winds, the Sea, and the Land-Breezes; (e) the one serving to carry the Mariner in long Voyages from East to West; the other serving to wast him to particular Places;

Experiments I have made (altho' I have unfortunately forgotten them) in very cold Weather, I imagine the Heat of an healthy Body to be always much the fame in the warmest Parts thereof, both in Summer and Winter. Now between those very Degrees of 284, and 288, the Point of the equatorial Heat falleth. From which Observation it appears, that there is pretty nearly an equal Contemperament of the Warmth of our Bodies, to that of the hottest Part of the Atmosphere inhabited by us.

If the Proportion of the Degrees of Heat be defired from the Freezing-Point, to the Winter, Spring, and Summer Air, the Heat of Man's Body, of heated Water, melted Metals, and so to actual Fire; an Account may be met with of it, by my most ingenious Friend, the great Sir Isaac Newton, in

Phil. Transact. No. 270.

(d) In boc Providentia ac Dispositor ille Mundi Deus, aera ventis exercendum dedit,—non ut nos classes partem freti occupaturas empleremus milite armato, &c. Dedit ille ventos ad custodiendam cœli terrarumque temperiem, ad evocandas supprimendasque aquas, ad alendos satorum atque arborum fructus; quos ad maturitatem cum aliis causis adducit ipsa jactatio, attrabens cibum in summa. & ne torpeat, promovens. Dedit ventos ad ulteriora noscenda: suisse enim imperitum animal, & sine magna experientia rerum Homo, si circumscriberetur natalis soli sine. Dedit ventos ut commoda cujusque regionis sierent communia; non ut legiones equitemque gestarent, nec ut perniciosa gentibus arma transveherent. Seneca, ibid.

(e) Sea-Breezes commonly rife in the Morning about Nine a Clock.—They first approach the Shore gently, as if they were assaid to come near it.—It comes in a fine, small, black Curle upon the Water.

Places; the one ferving to carry him into his Harbour, the other to bring him out. But I should go too far to take Notice of all Particulars (f). Leaving therefore the Winds, I proceed, in the next Place, to the Clouds and Rain.

Water, whereas all the Sea between it and the Shore (not yet reached by it) is as smooth and even as Glass in Comparison. In half an Hours Time after it has reached the Shore, it fans pretty briskly, and so enereateth gradually till Twelve a Clock; then it is commonly the strongest, and lasts so till Two or Three, a very brisk Gale.—After Three it begins to die away again, and gradually withdraws its Force till all is spent; and about Five a Clock—it is lulled asleep, and comes no more till next Morning.

And as the Sea-Breezes do blow in the Day, and rest in the Night; so on the contrary [The Land-Breezes] blow in the Night, and rest in the Day, alternately succeeding each other.——They spring up between Six and Twelve at Night, and last till Six, Eight, or Ten in

the Morning. Dampier's Difc. of Winds, ch. 4.

(f) One Thing more I believe some of my Friends will expect from me is, That I shew the Result of comparing my own Observations of the Winds, with others they know I have from Ireland, Switzerland, Italy, France, New-England, and fome of our Parts of England. But the Observations being, some of them, but of one Year, and most of the rest of but a few Years, I have not been able to determine any great Matters. The Chief of what I have observed is, That the Winds in all these Places seldom agree; but when they most certainly do fo, it is commonly when the Winds are strong, and of long Continuance in the fame Quarter: And more, I think, in the Northerly and Easterly, than other Points. Alfo, a strong Wind in one Place, is oftentimes a weak one in another Place. or moderate, according as Places have been nearer or farther distant. Vide Philosoph. Transast. No. 297, and 321. But to give a good and tolerable Account of this, or any other of the Weather, it is necessary to have good Histories thereof from all Parts; which, as yet we have but few of, and they imperfest, for want of longer and fufficient Observations.

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CHAP. III. Of the Clouds and Rain.

HE Clouds and Rain (a) we shall find to be no less useful Meteors than the last mentioned; as is manifest in the refreshing pleasant Shades which the Clouds afford, and the fertile Dews and Showers which they pour down on the Trees and Plants, which would languish and die with

(a) Clouds and Rain are made of Vapours raised from Water, or Moisture only. So that I utterly exclude the Notion of Dry, Terene Exhalations, or Fumes, talked much of by most Philosophers; Fumes being really no other than the humid Parts of Bodies respectively Dry.

These Vapours are demonstratively no other than small Bubbles, or Vesiculæ detached from the Waters by the Power of the Solar, or Subterraneous Heat, or both. Of which see Book 2. Chap. 5. Note (b). And being lighter than the Atmosphere, are buoyed up thereby, until they become of an equal Weight therewith, in some of its Regions alost in the Air, or nearer the Earth; in which those Vapours are formed into Clouds, Rain, Snow, Hail, Lightning, Dew, Mils, and other Meteors.

In this Formation of Meteors the grand Agent is Cold, which commonly, if not always, occupies the superior Regions of the Air; as is manifest from those Mountains which exalt their lofty Tops into the upper and middle Regions, and are always covered with Snow and Ice.

This Cold, if it approaches near the Earth, presently precipitates the Vapours, either in Dews; or if the Vapours more copiously ascend, and soon meet the Cold, they are then condensed into Missing, or else into Showers of small Rain, falling in numerous, thick, small Drops: But if those Vapours are not only copious, but also as heavy as our lower Air it self, (by means their Bladders are thick and suller of Water,) in this Case they become visible, swim but a little Height above the Earth, and make what we call a Miss or Fog. But if they are a Degree lighter, so as to mount higher, but not any great Height, as also meet not with Cold enough to condense them, nor Wind to dissipate them, they then form an heavy,

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with perpetual Drought, but are hereby made Verdant and Flourishing, Gay and Ornamental; fo that

heavy, thick, dark Sky, lasting oftentimes for several Weeks without either Sun or Rain. And in this Case, I have scarce ever known it to Rain, till it hath been first Fair, and then Foul. And Mr. Clarke, (an ingenious Clergyman of Norfolk,) who in his Life-time, long before me, took notice of it, and kept a Register of the Weather for Thirty Years, which his learned Granson, Dr. Samuel Clarke put into my Hands, he, (Ifay) faith, he scarce ever observed the Rule to fail in all that Time; only he adds, If the Wind be in some of the easterly Points. But I have observed the same to happen, be the Wind where it will. And from what hath been faid, the Case is casily accounted for, viz. whilst the Vapours remain in the same State, the Weather doth fo too. And fuch Weather is generally attended with moderate Warmth, and with little or no Wind to disturb the Vapours, and an heavy Atmosphere to support them, the Barometer being commonly high then. But when the Cold approacheth, and by condenfing drives the Vapours into Clouds or Drops, then is way made for the Sun-beams, till the same Vapours, being by further Condenfation formed into Rain, fall down in Drops.

The Cold's approaching the Vapours, and confequently the Alteration of fuch dark Weather I have beforehand perceived, by fome few small Drops of Rain, Hail, or Snow, now and then falling, before any Alteration hath been in the Weather; which I take to be from the Cold meeting some of the straggling Vapours, or the uppermost of them, and condenfing them into Drops, before it arrives unto, and ex-

erts it felf upon the main Body of Vapours below.

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I have more largely than ordinary infifted upon this part of the Weather, partly as being somewhat out of the way; but chiefly, because it gives Light to many other Phanomena of the Weather. Particularly we may hence discover the Original of Clouds, Rain, Hail, and Snow; that they are Vapours carried aloft by the Gravity of the Air, which meeting together fo as to make a Fog above, they thereby form a Cloud. If the Cold condenfeth them into Drops, they then fall in Rain, if the Cold be not intense enough to freeze them: But if the Cold freezeth them in the Clouds, or in their Fall through the Air, they then become Hail or Snow.

As to Lightning, and other enkindled Vapours, I need fay little in this Place, and shall therefore only observe, that they

22 Of the Clouds and Rain. Book I.
(as the Psalmist saith, Psal. lxv. 12, 13.) The little Hills rejoice on every side, and the Valleys
shout for Foy, they also sing.

And

owe also their Rise to Vapours; but such Vapours as are detached from mineral Juices, or at least that are mingled with

them, and are Fired by Fermentation.

Another Phanomenon resolvable from what hath been said is, why a cold, is always a wet Summer, viz. because the Vapours rifing plentifully then, are by the Cold foon collected into Rain. A remarkable Instance of this we had in the Summer of 1708, part of which, especially about the Solftice, was much colder then usually. On June 12, it was so cold, that my Thermometer was near the Point of hoar Frost, and in some Places Theard there was an hoar Frost; and during all the cool Weather of that Month, we had frequent and large Rains, fo that the whole Month's Rain amounted to above two Inches Depth, which is a large Quantity for Upminster, even in the wettest Months. And not only with us at Upminster, but in other Places, particularly at Zurich in Switzerland, they feem to have had as unseasonable Cold and Wet as we. Fun bic mensis ____prater modum humidus. & magno quidem vegetabilibus hominibusque danno. Multum computruit Fanum, &c. complains the Industrious and learned Dr. F. F. Scheuchzer: Of which, and o ther Particulars, I have given a larger Account in Phil. Trans No. 321.

In which Transaction I have observed farther, that about the Equinoxes we (at Upminster at least) have oftentimes more Rain than at other Seasons. The Reason of which is manifest from what hath been said, viz, in Spring, when the Earth and Waters are loosed from the brumal Constipations, the Vapours arise in great Plenty: And the like they do in Autumn, when the Summer Heats, that both dissipated them, and warmed the superior Regions, are abated; and then the Cold of the superior Regions meeting them, condenseth them into Showers, more plentifully than at other Seasons, when either the Vapours are sewer, or the Cold that is to condense them is less.

The manner how Vapours are precipitated by the Cold, or reduced into Drops, I conceive to be thus: Vapours being, as I faid, no other than Inflated Vesiculæ of Water; when they meet with a colder Air than what is contained in them, the contained Air is reduced into a less Space, and the watery Shell or Case rendered thicker by that means, so as to become heavier than the Air, by which they are buoyed up, and consequently must needs fall down. Also many of those which needs

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And if to these Uses, we should add the Origine of Fountains and Rivers, to Vapours and the Rains,

hickned Vesicula run into one, and so form Drops, greater or inaller, according to the Quantity of Vapours collected to-

gether.

As to the Rain of different Places, I have in some of our fransactions affigned the Quantities; particularly in the last cied Transaction, I have affigued these, viz.-the Depth of the Rain one Year with another, in English Measure, if it was to tagnate on the Earth, would amount unto, at Townly in Lanaffire, 42 Inches and a half; at Upminster in Essex 19 Inches nd a quarter; at Zurich in Switzerland 32 Inches and a quarer; at Pisa in Italy 43 Inches and a quarter; at Paris in France

9 Inches; and at Lifle in Flanders 24 Inches.

It would be endless to reckon up the bloody and other prodiious Rains taken notice of by Historians, and other Authors s præternatural and ominous Accidents; but if strictly pried nto, will be found owing to natural Causes: Of which, for he Reader's Satisfaction, I will give an instance or two. A loody Rain was imagined to have fallen in France, which ut the Country People into so great a Fright, that they left heir Work in the Fields, and in great haste flew to the Neighouring Houses. Peirife (then in the Neighbourhood) strictly equiring into the Cause, found it to be only red Drops oming from a fort of Butterfly that flew about in great Sumbers at that Time, as he concluded from feeing fuch red Drops come from them; and because these Drops were laid, Non supra edificia, non in devexis lapidum superficiebus, uti debuerat coningere, si è coclo sanguine pluisset ; sed in subcavis potius & in foraminius.—Accessit, quòd parietes iis tingebantur, non qui in mediis oppidis. ed qui agrorum vicini erant, neque secundum partes elatiores, sed ad medicerem solum altitudinem, quantam volitare Papiliones solent.
Gassend. in vit. Peiresk, L. 2. p. 156.

So Dr. Merret faith alfo, Pluvia Sanguinis quam certissime conftat Je tantum Infectorum excrementa; Pluvia Tritici quam nibil aliud Je quam Hedera baccifera grana à Sturnis devorata excretaque com-

paranti liquidissime patet. Pinax rerum, &c. p. 220.

The curious Worm tells of the raining of Brimstone, Anno 1646. Maii 16. Hic Hafnia cum ingenti pluvia tota urbs, omnesque ita mundarentur platee, ut greffus hominum impediret, Sulphureoque odore airem inficeret, dilapsis aliquantulum aquis, quibusdam in locis colligere lant Sulphureum pulverem, cujus portionem servo, colore, odore, & aliis terum Sulphur ferentem, Muf. Worm. I. 1, c. 11. Sect. 1.

Rains, as some of the most eminent modern Philosophers

Together with the Rain we might take notice of other Meteors, particularly Snow; which although an irkfome Gueff, yet hathis great Uses, if all be true that the famous T. Bar. tholin faith of it, who wrote a Book de Nivis Usu Medico. In which he shews of what great Use Snow is in fructifying the Earth, preserving from the Plague, curing Fevers, Colicks, Head-Aches, Tooth-Aches, Sore Eyes, Plurifies, (for which Use he faith his Country-Women of Benmark keep Snow. water gathered in March,) also in prolonging Life, (of which he instanceth in the Alpine Inhabitants, that live to a great Age,) and preserving dead Bodies; Instances of which he gives in Persons buried under the Snow in passing the Ala, which are found uncorrupted in the Summer, when the Snow is melted; which fad Spectacle he himself was an Eye-Witness of. And at Spitzberg in Greenland, dead Bodies remain entire and uncorrupted for thirty Years. And lastly, concerning fuch as are fo prefery'd when flain, he faith they remaining the same Posture and Figure: Of which he gives this old Example. Visum id extra urbem nostram [Hafniam] quum, 11 ld. 1659. oppugnantes hostes repellerentur, magnaque strage occumberent; alis enim rigidi iratum vultum oftendebant, alii oculos elatos ; alii m diducto ringentes, alii brachiis extensis Gladium minari, alii alio sita prostrati jacebant. Barthol. de usu Niv. c. 12.

But although Snow be attended with the Effects here named, and others specified by the learned Bartholin; yet this is not to be attributed to any peculiar Virtue in the Snow, but some other Cause. Thus when it is said to frustify the Earth, it doth so by guarding the Corn or other Vegetables against the intenser Cold of the Air, especially the cold piercing Winds; which the Husbandmen observe to be the most injurious to their Corn of all Weathers. So for Conserving deal Bodies, it doth it by constipating such Bodies, and preventing all such Fermentations or internal Conslicts of their Parti-

cles, as would produce Corruption.

Such an Example as the preceding is faid to have happened some Years ago at Paris, in digging in a Cellar for supposed hidden Treasure; in which, after digging some Hours, the Maid going to call her Master, found them all in their digging Postures, but dead. This being noised abroad, brought innot only the People, but Magistrates also, who found them accordingly; like qui ligone terram effoderat, & socius qui pala effosion terram removerat, ambo pedibus stabant, quasi suo quisque operi affixus sacubuisset; uxor umus quasi ab opere defessa in scamno, folicito quodam vultu.

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CHAP. III. Of the Clouds and Rain. 2

fophers (b) have done, we should have another Instance of the great Use and Benefit of that Meteor.

And now, if we reflect upon this necessary Appendage of the Terraqueous Globe, the Atmosphere; and consider the absolute Necessity thereof to many. Uses of our Globe, and its great Convenience to the whole: And in a Word, that it answereth all the Ends and Purposes that we can suppose there can be for such an Appendage: Who can but own this to be the Contrivance, the Work of the Great Creator? Who would ever say or imagine such a Body, so different from the Globe it serves, could be made by Chance, or be adapted so exactly to all those fore-mentioned grand Ends, by any other Efficient than by the Power and Wisdom of the Infinite God!

vultu, sedebat, inclinato in palmam manûs genibus innitentis capite ; puerulus laxatis braccis in margine excavata sovea desixis in terram culis alvum exonerabat; omnes in naturalistu, carnea tanquam statua rigidi, apertis oculis & vultu vitam quasi respirante, exanimes stabant.

Dr. Bern. Conner, Differt. Med. Phys. p. 15.

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The Doctor attributes all this to Cold; but I scarce think there could be Cold enough to do all this at Paris, and in a Cellar too. But his following Stories are not improbable, of Men and Cattle killed with Cold, that remained in the very same Posture in which they died; of which he gives, from a Spanish Captain, this Instance, that happened two Years before, of a Soldier who unfortunately straggled from his Company that were foraging, and was killed with the Cold, but was thought to have fallen into the Enemies Hands. But soon after their return to their Quarters, they saw their Comrade returning, sitting on Horseback, and coming to congratulate him, sound him dead, and that he had been brought thither in the same Posture on Horseback, notwithstanding the jolting of the Horse, 1b. p. 18.

(b) Of this Opinion was my late most ingenious and learned Friend, Mr. Ray, whose Reasons see in his Physico-Theolog. Discourses, Disc. 2. ch. 2. p. 89, &c. So also my no less learned and ingenious Friends, Dr. Halley, and the late Dr. Hook, many of the French Vertuoso's also, and divers other very confiderable Men before them, too many to be specified here.

(c) An

Who would not rather, from so noble a Work. readily acknowledge the Workman, (c) and as eafily conclude the Atmosphere to be made by GoD, as an Inftrument wrought by its Power, any Pneumatick Engine, to be contrived and made by Man!

(c) An Polycletum quidem admirabimur propter partium Statuaconvenientiam ac proportionem? Naturam autem non modo non laudabimus, sed omni etiam arte privabimus, que partium proportionem non folum extrinsecus more Statuariorum, sed in profundo etiam servavit? Nonne & Polycletus ipse Natura est imitator, in quibus saltem eam potuit imitari? Potuit autem in solis externis partibus in quibus artem consideravit. With much more to the like Purpose. Galen. de Uf. Part. 1. 17. c. 1.

CHAP. IV. Of Light.

Hus much for the first Thing ministring to the Terraqueous Globe, the Atmosphere and its Meteors; the next Appendage is Light. (a) Concerning which, I have in my Survey of the Heavens (b) shewed what admirable Contrivances the infinitely wife Creator hath for

(a) It is not worth while to enumerate the Opinions of the Aristotelians, Cartesians, and others, about the Nature of Light, Aristotle making it a Quality; Cartes a Pulsion, or Motion of the Globules of the second Element. Vide Cartes Princip. p. 3. Sect. 55, 80. But with the Moderns, I take Light to confilt of material Particles, propagated from the Sun, and other luminous Bodies, not instantaneously, but in Time, according to the Notes following in this Chapter. But not to infift upon other Arguments for the Proof of it, our noble Founder hath proved the Materiality of Light and Heat, from actual Experiments on Silver, Copper, Tin, Lead, Spelter, Iron, Turenage, and other Bodies, exposed (both naked and closely thut up) to the Fire: All which were constantly found to receive an Increment of Weight. I wish he could have met with a favourable Season to have tried his Experiments with the Sun-Beams as he intended. Vide Boyle's Exp, to make Fire and Flame ponderable. (c) And

(b) Aftro-Theol. Book 7.

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the affording this noble, glorious, and comfortable Benefit to other Globes, as well as ours; the Provision he hath made by Moons, as well as by the

Sun, for the Communication of it.

And now let us briefly consider the great Necessity and Use thereof to all our Animal World. And this we shall find to be little less than the very Life and Pleasure of all those Creatures. For what Benefit would Life be of, what Pleasure, what Comfort would it be for us to live in perpetual Darkness? How could we provide our selves with Food and Necessaries? How could we go about the least Business, correspond with one another, or be of any Use in the World, or any Creatures be the same to us, without Light, and those admirable Organs of the Body, which the Great Creator hath adapted

to the Perception of that Great Benefit?

But now by the Help of this admirable, this firstmade (c), because most necessary, Creature of God;
by this, I say, all the Animal World is enabled to
go here and there, as their Occasions call; they can
transact their Business by Day, and refresh and recruit themselves by Night, with Rest and Sleep.
They can with Admiration and Pleasure, behold the
glorious Works of God; they can view the Glories
of the Heavens, and see the Beauties of the flowry
Fields, the gay Attire of the feathered Tribe, the
exquisite Garniture of many Quadrupeds, Insects,
and other Creatures; they can take in the delightsome Landskips of divers Countries and Places;
they can with Admiration see the Great Creator's
wonderful Art and Contrivance in the Parts of Ani-

⁽c) And God said, Let there be Light, and there was Light. Gen.

mals and Vegetables: And, in a Word, behold, the Harmony of this lower World, and of the Globes above, and furvey God's exquisite Workmanship

in every Creature.

To all which I might add the Improvements which the Sagacity of Men hath made of this noble Creature of God, by the Refractions and Reflections of Glasses. But it would be endless to enumerate all its particular Uses and Benefits to our World.

But before I leave this Point, there are two Things concerning Light, which will descrive an especial Remark; and that is, its swift and almost instanta-

neous Motion, and its vast Extension.

1. It is a very great Act of the Providence of God, that so great a Benefit as Light is, is not long in its Passage from Place to Place. For was the Motion thereof no swifter than the Motion of the swiftest Bodies on Earth, such as of a Bullet out of a great Gun; or even of a Sound (d) (which is the fwiftest Motion we have next Light,) in this Case

(d) It may not be ungrateful to the Curious, to take Notice of the Velocity of these two Things.

According to the Observations of Mersennus, a Bullet shot out of a great Gun, flies 92 Fathom in a Second of Time, (Vide Mersen. Balist.) which is equal to 589 English Feet and a half; and according to the Computation of Mr. Huygens, it would be 25 Years in passing from the Earth to the Sun. But according to my own Observations made with one of her late Majesty's Sakers, and a very accurate Pendulum-Chronometer, a Bullet, at its first Discharge, flies 510 Yards in five half Seconds, which is a Mile in a little above 17 half Seconds. And allowing the Sun's Distance to be, as in the next Note, a Bullet would be 32 Years and a halfin flying, with its utmost Velocity, to the Sun.

As to the Velocity of Sound, fee Book 4. Chap. 3. Note 28. according to which Rate there mentioned, a Sound would be mear 17 Years and a half in flying as far as the Distance is from the Earth to the Sun. Confer here the Experiments of the (e) Mr. Acad. del Ciment, p. 140, 000.

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Light would take up, in its Progress from the Sun to us, above thirty two Years, at the rate of the sirft; and above seventeen Years, at the rate of the latter Motion.

The Inconveniencies of which would be, its Energy and Vigour would be greatly cooled and abated; its Rays would be less penetrant; and Darkness would with greater Difficulty and much Sluggishness, be distipated, especially by the fainter Lights of our sublunary, luminous Bodies. But passing with such prodigious Velocity, with nearly the instantaneous Swiftness of almost Two hundred thousand English Miles in one Second of Time, (e) or (which is the same Thing) being but about seven or eight Minutes of an Hour in coming from the Sun to us, therefore with all Security and Speed, we receive the kindly Essects and Insluences of that noble and useful Creature of God.

2. Another Thing of great Confideration about Light is, its vast Expansion, its almost incomprehensible, and inconceivable Extension, which, as a late

⁽e) Mr. Romer's ingenious Hypothesis about the Velocity of Light, hath been established by the Royal Academy, and in the Observatory for eight Years, as our Phil. Trans. No. 136. observe from the Journ. des Scavans; our most eminent Astronomers also in England admit it: But Dr. Hook thinks with Monsieur Cartes, the Motion of Light Instantaneous, Hook Post. Works, pag. 77. And this he endeavours to explain, pag. 130, &c.

What Mr. Romer's Hypothesis is, may be seen in the Phil. Transatt. before-cited: As also in the before-commended Sir Isaac Newton's Opticks: Light is propagated from luminous Bodies in time, and spends about seven or eight Minutes of an Hour in passing from the Sun to the Earth. This was first observed by Romer, and then by others, by means of the Eclipses of the Satellites of Jupiter. For these Eclipses, when the Earth is between the Sun and Jupiter, happen about seven or eight Minutes sooner than they ought to do by the Tables; and when the Earth is beyond the Sun, they happen about seven or eight Minutes from the Sun, they happen about seven or eight Minutes sooner than they happen about seven or eight Minute

late ingenious Author (f) faith, "Is as boundless and unlimited as the Universe it self, or the Ex-

" pansum of all material Beings: The Vastness of which is so great, that it exceeds the Comprehen-

" fions of Man's Understanding. Insomuch, that

ce very many have afferted it absolutely Infinite,

and without any Limits or Bounds.

And that this noble Creature of God is of this Extent, (g) is manifest from our seeing some of the farthest distant Objects, the heavenly Bodies, some

nutes later than they ought to do: The reason being, that the Light of the Satellites hath farther to go in the latter Case than in the former, by the Diameter of the Earth's Orbit. Newt. Opt. L. 2. Part 3. Prop. 11.

Now forasmuch as the Distance between the Sun and the Earth (according to the Computations in my Astro-Theology, B. 1. ch. 3. Note 2.) is 86051398 English Miles; therefore, at the rate of 7 Minutes and half, or 450 Seconds, in passing from the Sun, Light will be found to sly above 191225 Miles

in one Second of Time.

(f) Dr. Hook's Posthumous Works. Left. of Light, p. 76. (g) For the Proof of this vast Extent of Light, I shall take the Computation of the same great Man, pag. 77. If, saith he, we consider first the vast Distance between us and the Sun, which from the best and latest Observations in Astronomy, is judged to be about 10000 Diameters of the Earth, each of which is about 7925 English Mila; therefore the Sun's Distance is 792,5000 Miles; and if we consider, That, according to the Observations, which I published to prove the Motion of the Earth, [which were Observations of the Parallax of some of the fix'd Stars in the Head of Draco, made in 1699, the whole Diameter of the Orb, viz. 2000, made the Subtense but of one Minute to one of the fix'd Stars, which cannot therefore be less distant than 3438 Diameters of this great Orb, and consequently 68760000 Diameters of the Earth: And if this Star be one of the nearest, and that the Stars that are of one Degree lesser in Magnitude (I mean not of the Second Magnitude, because there may be many Degrees between the first and second) be as much farther; and another Sort yet smaller be three Times as far; and a fourth four Times as far, and so onward, possibly to some 100 Degrees of Magnitude, such as may be discovered by longer and longer Telescopes, that they may be 100 Times as far; then certainly this material Expansion, a Part of which we are, must be so great, that 'twill infinitely exceed our shallow Conception to imagine. Now, by what I last mentioned, it

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with our naked Eye, some with the Help of Optical Instruments, and others in all Probability farther and farther, with better and better Instruments: And had we Instruments of Power equivalent to the Extent of Light, the luminous Bodies of the utmost Parts of the Universe, would, for the same Reason, be visible too.

Now as Light is of greatest Use to impower us to see Objects at all, so the Extension thereof is no less useful to enable us to see Objects afar off. By which Means we are afforded a Ken of those many glorious Works of the Infinite Creator, visible in the Heavens, and can improve them to some of the noblest Sciences, and most excellent Uses of our own Globe.

is evident, That Light extends it self to the utmost imaginable Parts, and by the Help of Telescopes we collect the Rays, and make them sensible to the Eye, which are emitted from some of the almost inconceivably renote Objects, &c.—Nor is it only the great Body of the Sun, or the sast Bodie of the fix'd Stars, that are thus able to disperse the Light brough the vast Expansum of the Universe; but the smallest Spark of a wid Body must do the very same Thing, even the smallest Globule struck from a Steel by a Flint, &c.

CHAP. V. Of Gravity.

THE last Thing subservient to our Globe, that I shall take Notice of, is Gravity (a); or, that Tendency which Bodies have to the Centre of the Earth.

⁽a) That there is such a Thing as Gravity, is manifest from its Effects here upon Earth; and that the Heavenly Bodies attract or gravitate to one another, when placed at due Distances, is made highly probable by Sir Isaac Newton. This attractive or gravitating Power, I take to be congenial to Matter, and imprinted on all the Matter of the Universe by the Creator's Fiat at the Creation. What the Cause of it is, the Newtonian Philosophy doth not pretend to determine for want of Phanomena, upon which Foundation it is that that

In my Astro-Theology, Book 6. Ch. 2. I have shewn of what absolute Necessity, and what a noble

Philsophy is grounded, and not upon chimerical and uncertain Hypotheses: But whatever the Cause is, that Cause penetrates even to the Centres of the Sun and Planets, without any Diminution of its Virtue; and it afteth not according to the Superficies of Bodies (as Mechanical Causes do) but in Proportion to the Quantity of their folid Matter: And lastly, It afteth all round it at immense Distances, decreasing in duplicate Proportion to those Distances, as Sir Isaac Newton faith, Princip. pag. ult. What useful Deductions, and what a rational Philosophy, have been drawn from hence, may be seen in the same Book.

This Attraction, or Gravity, as its Force is in a certain proportion, so makes the Descent of Bodies to be at a certain rate. And was it not for the Resistance of the Medium, all Bodies would descend to the Earth at the same rate; the lightest Down, as swiftly as the heaviest Mineral: As is manifest in the Air-Pump, in which the lightest Feather, Dust, &c. and a piece of Lead, drop down seemingly in the same Time, from the Top to the bottom of a tall exhausted Receiver.

The rate of the Descent of heavy Bodies, according to Galilao, Mr. Huyghens, and Dr. Halley (after them) is 16 Feet one Inch in one Second of Time; and in more Seconds, as the Squares of those Times. But in some accurate Experiments made in St. Paul's Dome, June 9. 1710. at the Height of 220 Feet, the Descent was scarcely 14 Feet in the first Second. The Experiments were made in the Presence of some very considerable Members of the Royal Society, by Mr. Hawkibee, their Operator, with glass, hollow Balls, some empty, some filled with Quick-silver, the Barometer at 297, the Thermometer 60 Degrees above Freezing. The Weight of the Balls, their Diameters, and Time of the Descent is in this Table.

Balls filled with Quick-Silver.			Empty Balls.			
Weight.	Diameter.	Time.	Weight.	Diameter.		Time.
Grains.	Tenth Inch.	halt Seconds.	Grains.	Inch.	Tenth.	half Second
908	8	8	. 510	5	Í	17
993	8	8 less.	642	5	2	16
866	8	8	\$99	5	1	16
747 808	7 & half		515			16 & hall
808	7 & half		483	s ne	early	17
784	7 & half	8 more.	641	15 1	2	16

The Reason why the heavy, full Balls fell in half the Time of the hollow ones, was the Resistance of the Air: Which Resistance is very ingeniously and accurately assigned by Dr. Wallis, in Philos. Trans. No. 186. And the Cause of the Resistance

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noble Contrivance this of Gravity is, for keeping the feveral Globes of the Universe from shattering to Pieces, as they evidently must do in a little Time, by their swift Rotation round their own Axes (b). The Terraqueous Globe particularly, which circumvolves at the rate of above 1000 Miles an Hour (c).

ance of all Fluids, (as Sir Ifaa: Newton, Opt. Q. 20.) is partly from the Friction of the Parts of the Fluid, partly from the Inertia thereof. The Resistance a spherical Body meets with from Friction, is as the right Angle under the Diameter, and the Velocity of the moving Body : And the Refistance from the Vis Inertia, is as the Square of that Product.

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For a farther Account of the Properties and Proportions, &c. of Gravity, in the Fall or Projection of Bodies, I shall refer to the larger Accounts of Galilaus, Torricellius, Huygens, Sir Isaac Newton, &c. or to the shorter Accounts of Dr. Halley, in Philosoph. Trans. abridged by Mr. Lowtherp, Vol. I. p. 561. or Dr. Clarke, in his Notes on Robault, Phys. 2. c. 28. sect. 13, 16. And for the Refistance of Fluids, I refer to Dr. Wallis, beforecited, and the Act. Erudit. Lips. May 1693, where there is a Way to find the Force of Medium's upon Bodies of different Figures.

(b) That the heavenly Bodies move round their own Axis. is, beyond all Doubt, manifest to our Eye, in some of them, from the Spots visible on them. The Spots on the Sun (easily visible with an ordinary Glass) do manifest him to revolve round his own Axis in about 25 Days and quarter. The Spots on Jupiter and Mars prove those two Planets to revolve also from East to West, as Dr. Hook discovered in 1664, and 1665. And Venus also (although near the strong Rays of the Sun) hath, from some Spots, been discovered by Mr. Cassini, in 1666; and 1667, to have a manifest Rotation, Vide Lowtborp's Abridg. Vol. I. p. 382, and 423, 425. And fuch Uniformity hath the Creator observed in the Works of Nature, that what is observable in one, is generally to be found in all others of the fame Kind. So that fince 'tis manifest the Sun, and three of his Planets whirl round, it is very reasonable to conclude all the

rest do so too; yea, every Globe of the Universe.
(c) The Earth's Circumference being 25031 Miles and half, (according to Book II. Chap. 2. Note (a.) if we divide that into 24 Hours, we shall find the Motion of the Earth to be near 1043 Miles in an Hour. Which, by the by, is a far more reasonable and less rapid Rate, than that of the Sun would would by the centrifugal Force of that Motion, be foon diffipated and spirtled into the circumambient Space, was it not kept together by this noble Contrivance of the Creator, this natural inherent Power, namely, the Power of Attraction or Gravity.

And as by this Power our Globe is defended against Dissipation, so all its Parts are kept in their proper Place and Order. All material Things do naturally gravitate thereto, and unite themselves therewith, and fo preserve its Bulk intire (d). And the fleeting Waters, the most unruly of all its Parts, do by this Means keep their constant Æquipoise in the Globe (e), and remain in that Place which, the Pfalmist saith, God bath founded for them; a Bound he had set, which they might not pass; that they turn not again to cover the Earth, Plal. civ. 8, 9. So, that even in a natural Way, by Virtue of this excellent Contrivance of the Creator, the Observation of the Psalmist is perpetually fulfilled, Pfal. lxxxix. 9. Thou ruleft the raging of the Sea; when the Waves thereof arife, thou stillest them.

To these, and an hundred other Uses of Gravity that I might have named, I shall only just mention another thing owing to it, and that is Levity

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be, if we suppose the Earth to stand still, and the Sun to move round the Earth. For according to the Proportions in Note (e), of the preceding Chapter, the Circumference of the Magnus Orbis is 540686225 English Miles, which divided by 24 Hours, gives 22528364 Miles in an Hour. But what is this to the Rapidity of the fix'd Stars, if we suppose them, not the Earth, to move? Which is a good Argument for the Earth's Motion.

⁽d) Nibil majus, quam quod ita stabilis est Mundus, atque ita coberet ad permanendum, ut nibil ne excogitari quidem possit aptius. Omnes enim partes ejus undique medium locum capessentes, nituntur aqualiter: maxime autem corpora inter se juncta permanent, cum quodam quas vincula

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(f) that, whereby what we call light Bodies fwim. a Thing no less uleful to the World than its oppofite, Gravity, is in many Respects, to divers Tribes of Animals, but particularly serviceable to the raifing up of Vapours (g), and to their Conveyance about the World.

vincule circumdata colligantur: quod facit ea natura, que per omnem mundum omnia Mente, & Ratione conficiens, funditur, & ad medium rapit. & convertit extrema. Cic. de Nat. Deor. 1. 2. c. 45.

(e) Eadem ratione Mare, cum supra terram sit, medium tamen terra locum expetens, conglobatur undique aqualiter, neque redundat, un-

quam, neque effunditur. Id. paulo post.

(f) That there is no fuch Thing as positive Levity, but that Levity is only a less Gravity, is abundantly manifested by the acute Seig. Alph. Borelli de Mot. à Grav. pend. cap. 4. See also the Annotations of the learned and ingenious Dr. Clark, on Rohaulti Phys. p. 1. c. 16. Note 3. Also the Experiments of the Acad, del Cimento, p. 118, &c. Dr. Wallis's Discourse of Gravity and Gravitation before the Royal Society, Nov. 12. 1674. p. 28, 8.

(g) I have before in Note (a), Chap. 3. Shewn what Vapours are, and how they are rais'd. That which I shall here note, is heir Quantity: Concerning which, the before-commended Dr. Halley hath given us some curious Experiments in our Phi-Joph. Tranf. which may be met with together in Mr. Lowthorp's Abridg. Vol. II. p. 108, and 126. Mr. Sedileau also at Paris obferved it for near three Years. By all their Observations it appears, that in the Winter Months the Evaporations are least, and greatest in Summer, and most of all in windy Weather. And by Monsieur Sedileau's Observations it appears, that what is raifed in Vapours, exceeds that which falleth in Rain. In the seven last Months of the Year 1688, the Evaporations amounted to 22 Inches 5 Lines; but the Rain only to Inches 6 Lines one third: In 1689, the Evaporations were 32 Inches 10 Lines and half; but the Rain 18 Inches I Line: In 1690, the Evaporations 30 Inches 11 Lines; the Rain 21 Inches one third of a Line. Vide Mem. de Math. Phys. Ann. 1692. p. 25.

If it be demanded, What becomes of the Overplus of Exhalations that descend not in Rain? I answer, They are partly tumbled down and spent by the Winds, and partly descend in Dews, which amount to a greater Quantity than is commonly imagined. Dr. Halley found the Descent of Vapours in Dews to prodigious at St. Helena, that he makes no doubt to attribute the Origin of Fountains thereto. And I my felf have iten in a still, cool Evening, large thick Clouds hanging, with-

BOOK I.

And now from this transient View of no other than the Out-works, than the bare Appendages of the Terraqueous Globe, we have so manifest a Sample of the Wisdom, Power, and Goodness of the Infinite Creator, that it is easy to imagine the whole Fabrick is of a Piece, the Work of at least a Skilful Artist. A Manthat should meet with a Palace (b) befet with pleafant Gardens, adorned with stately Avenues, furnished with well-contrived Aqueducts, Cascades, and all other Appendages conducing to Convenience or Pleasure, would easily imagine, that proportionable Architecture and Magnificence were within: But we should conclude the Man was out of his Wits that should affert and plead, that all was the Work of Chance, or other than of some wife and skilful Hand. And so when we Survey the bare Out-works of this our Globe, when we fee to vast a Body, accouter'd with so noble a Furniture of Air, Light, and Gravity; with every Thing, in fhort, that is necessary to the Preservation and Security of the Globe it felf, or that conduceth to the Life, Health, and Happiness, to the Propagation and Increase of all the prodigious Variety of Creatures the Globe is stocked with; when we see nothing wanting, nothing redundant or frivolous, nothing botching or ill-made, but that every Thing, even in the very Appendages alone, exactly answereth all its Ends and Occasions: What else can be concluded, but that all was made with manifelt Defign, and that all the whole Structure is the Work of some Intelligent Being; some Artist, of Power and Skill equivalent to fuch a Work?

out any Motion in the Air, which in two or three Hours Time have been melted down by Degrees, by the cold of the Evening, fo that not any the least Remains of them have been left. BOOK

(b) See Book II. Chap. 3. Note (c).

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BOOK II.

Of the Terraqueous Globe it self in General.

Out-works, let us take a Survey of the Principal Fabrick, viz. the Terraqueous Globe it felf; a most stupendious Work in every Particular of it, which doth no less Aggrandize its Maker (a), than every curious, complete Work doth its Workman. Let us cast our Eyes here and there, let us ransack all the Globe, let us with the greatest Accuracy inspect every Part thereof, search out the inmost Secrets of any of the Creatures; let us examine them with all our Gauges, measure them with our nicest Rules, pry into them with our Microscopes,

(b) I

⁽a) Livet—oculis quodammodo contemplari pulchritudinem earum rerum, quas Divina Providentia dicimus constitutas. Ac principio Terra universa cernatur, locata in media mundi sede, solida, & globosa vestita storibus, berbis, arboribus, frugibus. Quorum omnium imredibilis multitudo, insatiabili varietate distinguitur. Adde huc Fontium gelidas perennitates, liquores pertucidos Amnium, Riparum vestitus verdidissimos, Speluncarum concavas attitudines, Saxorum asperitates, impendentium Montium altitudines, immensitates que Camporum: Adde etiam reconditas Auri—venas—Qua vero, & quam varia genera Bestiarum?—Qui Volucrum sapsus, atque cantus? Qui Pecudum paetus?—Quid de Hominum genere dicam? Qui quasi cultores terra constituti, & c:—Qua si, ut animis, sic oculis vider: possemus, nemo cunetam intuens terram, de Divina Ratione dubitaret. Cic. de Nat. Deor. 1, 2, c. 39.

38 Of the Terraqueous Globe, &c. Book II. croscopes, and most exquisite Instruments (&), still we find them to bear Testimony to their Infinite Workman; and that they exceed all human Skill fo far, as that the most exquisite Copies and Imitations of the best Artists, are no other than rude bungling Pieces to them. And so far are we from being able to espy any Defect or Fault in them, that the better we know them, the more we admire them; and the farther we see into them, the more exquisite we find them to be.

And for a Demonstration of this, I shall,

I. Take a general Prospect of the Terraqueous Clobe.

II. Survey its Particulars.

I. The Things which will fall under a general Prospect of the Globe, will be its Figure, Bulk, Motion, Place, Distribution into Earth and Waters, and the great Variety of all Things upon it and in it.

⁽b) I cannot here omit the Observations that have been made in these later Times, since we have had the Use and Improvement of the Microscope, concerning the great Difference, which by the Help of that, doth appear betwixt Natural and Artificial Things. Whatever is Natural, doth by that appear adorned with all imaginable Elegance and Beauty. -- Whereas the most curious Works of Art, the sharpest, finest Needle, deth appear as a blunt, rough Bar of Iron, coming from the Iunace, or the Forge. The most accurate Engravings or Embosments feem such rude, bungling, deformed Works, as if they had been done with a Mattock, or a Trowel. So vast a Difference is there betwint the Skill of Nature, and the Rudeness and Impersection of Art. Bistop Wilk. Nat. Rel. L. 1. Ch. 6.



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CHAP. I.

Of the Figure of the Terraqueous Globe.

THIS I suppose I may take for granted to be Spherical, or nearly so (a). And this must be allowed to be the most commodious, apt Figure for a World on many Accounts; as it is most capacious, as its Surface is equi-distant from the Centre,

not

(a) Although the Terraqueous Globe be of an orbicular Figure, yet it is not strictly so, r. On account of its Hills and Vallies. But these are inconsiderable to the Earth's Semi-diameter; for they are but as the Dust upon a common Globe. But, 2. Our modern Astronomers assign a much greater Variation from a globous Form, namely, that of a prolate Sphæroid, making the Polar about 34 Miles shorter than the Equatorial Diameter. The Cause of which they make to be the tentrifugal Force of the diurnal Rotation of the Globe.

This Figure they imagine is in Jupiter, his Polar being to his Equatorial Diameter; as 39 three fifths to 40 three fifths. But whether it be so or no, I confess I could never perceive, altho' I have often viewed that Planet through very good, and long Glasses, particularly a tolerable good one of 72 Feet in my Hands: And although by reason of cloudy Weather, and (at present) Jupiter's Proximity to the Sun, I have not been of late able to take a review of that Planet; yet Saturn (so far as his Ring would permit,) and Mars appear persectly round, through Mr. Huygens's long Glass of 126 Feet, which by Will he bequeathed, with its whole Apparatus, to our R, S. by whose Favour it is now in my Hands. And moreover, I believe it difficult, next to impossible, to measure the two Diameters to a 40th Part, by reason of the sinallness of Jupiter's apparent Diameter, and by reason he is moving all the Time of measuring him.

As to what is alledged from lengthening the Pendulums of Clocks, to make them keep the same Time under the Equator, as they do in our Climes: I have shewn from the like Variations in the Air-Pump, that this may arise from the rarity of the Air there, more than here. Vid. Phil. Trans. No. 294. But if the Degrees of a Meridian grow larger, the more we go to-

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BOOK II, Carly) of Gra-

not only of the Globe, but at least (nearly) of Gravity and Motion too, and as some have thought, of the central Heat and Waters. But these, and divers other Things I shall pass over, and insist only upon two or three other Benefits of this globous Figure

of the Earth and Waters.

of Heat, and I may add of Light also in some meafure. For by this means, those two great Benefits are uniformally and equally imparted to the World: They come harmoniously and gradually on, and as gradually go off again. So that the daily and yearly Returns of Light and Darkness, Cold and Heat, Moist and Dry, are Regular and Workman-like, (we may say,) which they would not be, especially the former, if the Mass of Earth and Waters were

wards the Line, (as Mr. Cassini affirms they do, by an 800th Part in every Degree, in Phil. Trans. No. 278.) then there is great Reason to conclude in behalf of this Sphæroidal Form.

The natural Cause of this Sphericity of our Globe, is (according to Sir Isaac Newton's Principles) that Attraction, which the Infinite Creator hath stamp'd on all the Matter of the Univerie, whereby all Bodies, and all the Parts of Bodies, murually attract themselves, and one another. By which means, as all the Parts of Bodies tend naturally to their Centre, to they all betake themselves to a globous Figure, unless some other more prevalent Cause interpose. Thus Drops of Quickfilver put on a spherical Form, the Parts thereof strongly attracting one another, So Drops of Water have the same Form, when falling in the Air; but are Hemispherical only when they lie on a hard Body, by reason their Gravity doth so tar over-power their felf-attracting Power, as to take off one half of their Sphericity. This Figure is commonly attributed to the Pressure of the circumambient Air: But that this can't be the Cause, is manifest from the Air-Pump; the Case being the very same in an exhausted Receiver, as in the open Air, and not any the least Alteration of the Figure that I could perceive, in all the Trials I have made. (b) It

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(as some fancied (b) it) a large Plain; or as others, like a large Hill in the midst of the Ocean; or of

a multangular Figure; or fuch like.

modious and equal Distribution of the Waters in the Globe. For since, by the Laws of Gravity, the Waters will posses the lowest Place; therefore, if the Mass of the Earth was cubick, prismatick, or any other angular Figure, it would follow, that one (too vast a Part) would be drowned; and another be too dry. But being thus orbicular, the Waters are equally and commodiously distributed here and there, according as the Divine Providence saw most sit; of which I shall take Notice by and by.

3. The orbicular Figure of our Globe, is far the most beneficial to the Winds and Motions of the Atmosphere. It is not to be doubted, if the Earth was of some other, or indeed any other Figure, but that the Currents of Air would be much retarded, if not wholly stopped. We find by Experience, what Insluence large and high Mountains, Bays, Capes, and Head-lands have upon the Winds; how they stop some, retard many, and divert and change (near the Shores) even the general and constant

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⁽b) It would be frivolous, as well as endless, to reckon up the various Opinions of the Ancients about the Figure of the Terraqueous Globe; some of them may be seen in Varen. Geogr. 1. 1. c. 3. init, or Jonston's Thaumat. c. 1. Artic. 3. But among the variety of Opinions, one of the principal was, That the visible Horizon was the Bounds of the Earth, and the Ocean the Bounds of the Horizon, that the Heavens and Earth above this Ocean, was the whole visible Universe; and that all beneath the Ocean was Hades, or the invisible World. Hence, when the Sun set, he was said tingere se Oceano; and when any went to Hades, they must first pass the Ocean. Of this Opinion were not only the ancient Poets, and others among the Heathens.

Winds (c), that blow round the Globe in the Torrid Zone. And therefore, fince this is the Effect of such little Excrescences, which have but little Proportion to our Globe, what would be the Consequences of much vaster Angles, which would equal a Quarter, Tenth, or but an Hundredth Part of the Globe's Radius? Certainly these must be such a Barricade, as would greatly annoy, or rather absolutely stop the Currents of the Atmosphere, and thereby deprive the World of those salutiferous Gales that I have said keep it sweet and clean.

be a Work of Contrivance, inafmuch as it is of the most commodious Figure; and all others would be liable to great and evident Inconveniences.

Heathens, but some of the Christian Fathers too, particularly Lastantius, St. Augustine, and others, who thought their Opinion was favoured by the Pfalmill, in Pfalm xxiv. 2. and exxxvi. 6. See Bp. Uper's Ans. to a fes. Chall. p. 366, &c.

(c) Neither do these constant Trade Winds usually blow near the Shore, but only on the Ocean, at least 30 or 40 Leagues off at Sas, clear from any Land; especially on the West Coast, or Side of any Continent: For indeed on the East Side, the Easterly Wind being the true Trade-Wind, blows almost home to the Shore, so near as to receive a Check from the Land-Wind. Dampier's Winds, Ch. 1.

And not only the general Trade-Winds, but also the constant coasting Trade-Winds, are in like manner affected by the Lands. Thus, for Instance, on the Coast of Angola and Peru, But this, saith the curious Captain Dampier, the Reader must take notice of, That the Trade-Winds that blow on any Coast, except the North Coast of Africa, whether they are constant, and blow all the Tear, or whether they are spifting Winds, do never blow right in on the Shore, nor right along Shore, but go stanting, making an acute Angle of about 22 Degrees. Therefore, as the Land tends more East or West, from North or South on the Coast; so the Winds do alter accordingly. Ibid. ch. 2.

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Of the Bulk of the Terraqueous Globe.

HE next Thing remarkable in the Terraqueous Globe, is the prodigious Bulk thereof (a). A Mass of above 260 Thousand
Million of Miles solid Content. A Work too grand
for any thing less than a God to make. To which
in the next Place we may add,

(a) It is not difficult to make a pretty near Computation of the Bulk of the Terraqueous Globe, from those accurate Obfervations of a Degree made by Mr. Norwood in England, and Mr. Picart, and Mr. Cassini in France. Whose Measures do in a surprizing manner agree. But Mr. Cassini's seeming to be the most accurate, (as I have shewn in my Astro-Theology, B. 1. Ch. 2. Note (a,) I have there made use of his Determinations. According to which the Diameter of the Earth being 7967,72 English Miles, its Ambit will be 25031 Miles and half; and supposing it to be Spherical) its Surface will be 199444220 Miles; which being multiplied into one third of its Semidiameter, gives the solid Content, viz. 264856000000 Miles.

CHAP. III.

The Motions of the Terraqueous Globe.

THE Motions the Terraqueous Globe hath, are round its own Axis, and round its Fountain of Light and Heat, the Sun (a). That so vast a Body as the Earth and Waters should be moved at

⁽a) With the Copernicans, I take it here for granted, that the Diurnal and Annual Revolutions are the Motions of the Terraqueous Globe, not of the Sun, &c. but for the Proof thereof I shall refer the Reader to the Preface of my Afro-Theology, and B. A. Chap. 3, (b) Every

all (b), that it should undergo two such different

Motions, as the Diurnal and Annual are, and that

these Motions should be so constant and regularly

(c) performed for near 6000 Years, without any

the least Alteration ever heard of (except some

Hours which we read of in Fost. x. 12, 13. and

in Hezekiah's Time, which, if they cannot be ac-

counted for some other way, do greatly encrease

the Wonder (d); these Things, I say,) do manifestly

BOOK II.

(b) Every Thing that is moved, must of Necessity be moved by something elfe; and that Thing is moved by something that is moved either by another Thing, or not by another Thing. If it be moved by that which is moved by another, we must of Necessity come to some prime Mover, that is not moved by another. For it is impossible, that what moveth, and is moved by another, sould proceed in Infinitum. An-Stot. Phys. 1. 8. c. 5.

Solum quod seipsum movet, quia nunquam deseritur à se, nunquant ne moveri quidem desinit : quinetiam ceteric que moventur, bic sons: boc principium est movendi. Principii autem nulla est origo : namex principio oriuntur omnia ; ipsum autem nulla ex re alia nasci potest: nec enim effet id principium, quod gigneretur aliunde. Cicer. Tulc.

Quest. 1. 1. c. 23.

Cogitemus qui fieri possit, ut tanta magnitudo, ab aliqua possit natura, tanto tempore circumferri? Ego igitur affero Deum causam esse, no

aliter poffe fieri. Plato in Epinom.

(c) Among the Causes which Cleambes is faid in Tully to affign for Men's Belief of a Deity, one of the chief is, Aquabilitatem motus, conversionem Coli, Solis, Luna, Siderumque omnium distinctionem, varietatem, pulchritudinem, ordinem: quarum rerum afpectus ipse satis indicaret, non esse ea fortuita. Ut siquis in domun aliquam, aut in gymnasium, aut in forum venerit; cum videat omnium rerum rationem, modum, disciplinam, non possit ea sine causa sieri judicare, sed esse aliquem intelligat, qui prasit, & cui pareatur: multo magis in tantis motibus, tantisque vicissitudinibus, tam multarum rerum atque tantarum ordinibus, in quibus nibil unquam immensa & infinita vetufas mentita sit, statuat necesse est ab aliqua Mente tantos natura motus gubernari. Cic. de Nat. Deor. 1. 2. c. 5.

Homines coeperunt Deum agnoscere, cum viderent Stellas, tantam coneinnitatem efficere; ac dies, noctesque, aftate, & hyeme, suos servare statos ortus, atque obitus. Plutarch de placit. 1. 1. c. 6.

(d) We need not be folicitous to elude the History of thefe Miracles,

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Mirac and fo an ord Days as if th But ir of Fat been 1 Habakk fore to of Nat ments the E ations, in 70/ fome] I fay, at firf

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argue some Divine Infinite Power to be concerned therein (e): But especially, if to all this we add the wonderful Convenience, yea absolute Necessity of these Circumvolutions to the Inhabitants, yea all the Products of the Earth and Waters. For to one of these we owe the comfortable Changes of Day and Night; the one for Business, the other for Repose; (f) the one for Man, and most other Animals to gather and provide Food, Habitation, and other

Miracles, as if they were only poetical Strains, as Maimonides, and some others fancy Fostuab's Day to have been, viz. only an ordinary Summer's-Day; but fuch as had the Work of many Days done in it; and therefore by a poetical Stretch made. as if the Day had been lengthened by the Sun standing still. But in the History they are feriously related, as real Matters of Fact, and with fuch Circumstances as manifest them to have been miraculous Works of the Almighty: And the Prophet Habakkuk, iii. 11. mentions that of Johna as such. And therefore taking them to be miraculous Perversions of the Course of Nature, instead of being Objections, they are great Arguments of the Power of God: For in Hezekiab's Cafe, to wheel the Earth it self backward, or by some extraordinary Refra-Stions, to bring the Sun's Shadow backward 10 Degrees: Or in Foshua's Case, to stop the diurnal Course of the Globe for some Hours, and then again give it the same Motion; to do, I fay, these Things, required the same Infinite Power which at first gave the Terraqueous Globe its Motions.

(e) Nam cùm dispositi quasissem swaera Mundi,
Prascriptosque Maris sines, Annique meatus,
Et Lucis, Noctisque vices: tunc omnia rebar
Consilio sirmata Dei, qui lege moveri
Sidera, qui fruges diverso tempore nasci,
Qui variam Phwben alieno jusserit igne
Compleri, Solemque suo; porrexerit undis
Littora; Tellurem medio libraverat axe.
Claudian in Rusin. L. 1. initio.

(f) Diei noctifque vicissitudo conservat animantes, tribuens aliud agendi tempus, aliud quiescendi. Sic undique omni ratione concluditur,
Mente, Consilioque divino omnia in hoc mundo ad salutem omnium, conservationeusque admirabiliter administrari. Cicer. de Nat. Deor.
1. 2. c. 53. (g) The

other Necessaries of Life; the other to rest, resresh, and recruit their Spirits (g), wasted with the Labours of the Day. To the other of those Motions we owe the Seasons of Summer and Winter, Spring and Autumn, together with the beneficial Instances and Effects which these have on the Bodies and State of Animals, Vegetables, and all other Things, both in the Torrid, Temperate, and Frigid Zones.

(g) The acute Dr. Cheyne, in his ingenious Philof. Princ. of Natural Religion, among other Uses of Day and Night, saith, the Night is most proper for Sleep; because when the Sun is above the Horizon, Sleep is prejudicial, by reason the Perspirations are then too great. Also that Nutrition is mostly, if not altogether, performed in Time of Rest; the Blood having too quick a Motion in the Day; For which Reason, weak Persons, Children, &c. are nourished most, and recruit best by Sleep.

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CHAP. IV.

Of the Place and Situation of the Terraqueous Globe, in respect of the Heavenly Bodies.

A Nother Thing very confiderable in our Globe, is its Place and Situation at a due Distance from the Sun (a), its Fountain of Light and Heat; and from its neighbouring Planets of the solar Sy-

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⁽a) It is a manifest Sign of the Creator's Management and Care, in placing the Terraqueous Globe, at that very Distance it is from the Sun, and contempering our own Bodies, and all other Things, so duly to that Distance. For was the Earth farther from the Sun, the World would be starved and frozen with Cold: And was it nigher we should be burnt, at least the most combustible Things would be so, and the World would be vexed with perpetual Conflagrations. For we see that a sew of the Rays of the Sun, even no more than what fall within the Compass of half an Inch or an Inch in a Burning-Glass, will fire combustible Bodies, even in our own Climate.

them, and from the fixt Stars. But these Things I have spoken more largely of in my Survey of the Heavens (b), and therefore only barely mention them now; to insist more largely upon,

(b) Aftro-Theology, Book vii. Chap. 7.

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CHAP. V.

The Distribution of the Earth and Water's:

THE Distribution of the Waters and the dry Land, although it may seem rude and undefigned to a careless View, and is by some taxed as such (a), yet is admirably well adjusted to the Uses and Conveniences of our World.

(a) The most eminent Author I have met with, that finds ault with the Distribution of the Earth and Waters, and inleed with the whole prefent Structure of the Globe, is the earned and eloquent Theorist, Dr. Burnet, who frequently exclaims on this Point : Tellus nostra, si totam simul complect amur, non est ordinata & venusta rerum compages—sed moles aggesta vario. meertoque situ partium, nulla ordinis aut venustatis habita ratione. Theor. Sacr. l. 1. c. 7. Ecquis autem à Dee hac ita facta? &c. b. Quo autem Herculeo labore opus effet ad excavandam terram in tanum biatum? - Si immediate à causa prima effectus suisset bic alveus aliquem saltem ordinem, mensuram. & proportionem notare voluisset in psius forma, & partium dispositione;—sed confusa omnia, &c. ib. c. 8. Tellus nostra cum exigua sit; est etiam rudis: Et in illa exiguitate multa sunt superflua, multa inelegantia. Dimidiam terra superficiem nundat Oceanus; magna ex parte, ut mihi videtur, inutilis. And then he goes on to shew how this Part of the Creation might be mended, ib. c. 10. All this is to me fur prizing from an Author of great Ingenuity, who feems in his Book to have a just Opinion of, and due Veneration for God. But certainly fuch Notions are very inconfistent with the Belief of God's creating, especially his governing and ordering the World. But suppose the Terraqueous Globe was such a rude, confused, inconvenient Mass, as he pretends, yet it is well enough for a finful World. But besides, what others have long ago abundantly answered, the following Survey, will, I hope, suffici-

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For in the first Place, the Distribution is so well made, the Earth and Waters fo handsomely, fo Workman-like laid, every where all the World o. ver, that there is a just æquipoise of the wholeGlobe, The Northern balanceth the Southern Ocean, the Atlantick the Pacifick Sea. The American dry Land, is a Counterpoise to the European, Asiatick and African.

In the next Place, the Earth and the Waters are fo admirably well placed about in the Globe, as to be helpful to one another, to minister to one another's Uses. The great Oceans, and the lesser Seas and Lakes, are so admirably well distributed throughout the Globe (b), as to afford sufficient Vapours (c) for

Clouds

ently manifest it to be the Work of a Wife and Beneficent, as well as Omnipotent Creator.

(b) Some have objected against the Distribution of the Earth and Waters, as if the Waters occupied too large a Part of the Globe, which they think would be of greater Use, if it was dry Land. But then they do not confider that this would deprive the World of a due Quantity of Vapours and Rain. For if the Cavities, which contain the Sea, and other Waters, were deeper, although the Waters were no less in Quantity, only their Surfaces narrower and leffer, the Evaporations would be so much the less, inasmuch as those Evaporations are made from the Surface, and are, confequently, in Proportion to the Surface, not the Depth or Quantity of Water.

(c) I took notice before in Book I. Chap. 3. Note (a). That the Vapours constituting Clouds and Rain, are Vesicula of Water detached by Heat. The manner of which I conceive to be thus; Heat being of an agile Nature, or the lightest of all Bodies, eafily breaks loofe from them; and if they are humid, in its Passage, carries along with it Particles, or little Cases of the Water; which being lighter than Air, are buoyed up thereby, and fwim in it; until by knocking against one another, or being thickened by the Cold, (as in the Note beforecited,) they are reduced into Clouds and Drops.

Having mentioned the manner how Vapours are raised, and there being more Room here than in the Note before-cited, I fhall,

CHAP. V. Earth and Waters.

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Clouds and Rains, to temperate the Cold (c) of the Northern frozen Air, to cool and mitigate the Heats

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hall, for the Illustration of Nature's Process, take notice of three Things observable to our Purpose, in Water over the Fire. I. That the Evaporations are proportional to the Heat scending out of the Water. A small Heat throws off but few Vapours, scarce visible: A greater Heat; and ascending in greater Quantities, carries off groffer, larger, and more numerous Vesicula, which we call a Steam: And if the Heat breaks through the Water with fuch a Fury, as to lacerate and lift up great Quantities or Bubbles of Water, too heavy for the Air to carry or buoy up, it causeth what we call Boyling. And the Particles of Water thus mounted up by the Heat, are visible Sphærules of Water, if viewed with a Microscope, as they swim about in a Ray of the Sun let into a datk Room; with warm Water underneath; where some of the Vapours appear large, fome fmaller Sphærules, according (no doubt) to the larger and leffer Quantities of Heat blowing them up and carrying them off. 2. If these Vapours be intercepted in their Ascent by any Context, especially cold Body, as Glass, Marble, &c. they are thereby reduced into Drops, and Masses of Water, like those of Rain, &c. 3. These Vapours in their Ascent from the Water, may be observed, in cold frosty Weather, either to rife but a little above the Water, and there to hang, or to glide on a little above its Surface: Or if the Weather be very cold, after a little Ascent, they may be seen to fall back again into the Water; in their Afcent and Defrent describing a Curve somewhat like that of an Arrow from a Bow. But in a warmer Air, and still, the Vapours ascend more nimbly and copiously, mounting up aloft, till they are out of Sight. But if the Air be warm and windy too, the Vapours are sooner carried out of Sight, and make way for others. And accordingly I have often observed, that hor Liquors, if not fet too thin, and not frequently stirred, cool flower in the greatest Frosts, than in temperate Weather, especially if windy. And it is manifest by good Experiments, that the Evaporations are less at those Times than these; less by far in the Winter than the warmer Months.

(c) As our Northern Hlands are observed to be more temperate than our Continents, (of which we had a notable Inflance in the great Frost in 1705, which Ireland and Scotland selt less of, than most Parts of Europe besides; of which see Book IV. Chap. 12. Note (c.) so this Temperature is owing to

Heats (d) of the Torrid Zone, and to refresh the Earth with fertile Showers; yea, in some Measureto minister fresh Waters to the Fountains and Rivers. Nay, fo abundant is this great Bleffing, which the most Indulgent Creator hath afforded us by Means of this Distribution of the Waters I am speaking of that there is more than a scanty, bare Provision, or mere Sufficiency; even a Plenty, a Surplufage of this useful Creature of God, (the fresh Waters) afforded to the World; and they so well ordered, as not to drown the Nations of the Earth, nor to stagnate, flink, and poifon, or annoy them; but to be gently carried through convenient Channels back again to their

the warm Vapours afforded chiefly by the Sea, which by the preceding Note must necessarily be warm, as they are Vapours,

or Water inflated by Heat.

The Cause of this Heat I take to be partly that of the Sun, and partly Subterraneous. That it is not wholly that of the Sun, is manifest from Vapours, being as, or more copioufly raifed when the Sun-Beams are weakest, as when strongeit, there being greater Rains and Winds at the one Time than the other. And that there is fuch a Thing as Subterraneous Heat, (whether Central, or from the Meeting of Mineral Juices; or fuch as is Congenial or Connatural to our Globe, I have not Time to enquire; but I fay that fuch a Thing is) is evident not only from the Hot-Baths, many fiery Erruptions and Explosions, &c. but also from the ordinary Warmth of Cellars and Places under Ground, which are not barely comparatively warm, but of fufficient Heat to raife Vapours also: As is manifest from the smoking of perennial Fountains in frosty Weather, and Water drawn out of Pumps and open Wells at fuch a Time. Yea, even Animals themselves are fenable of it, as particularly Moles, who dig before a Thaw, and against some other Alterations of the Weather; excited, no doubt, thereunto by the same warm Vapours arising in the Earth, which animate them, as well as produce the fucseeding Changes of the Weather.

(d) Besides the Trade-Winds, which serve to mitigate the exceffive Heats in the Torrid Zone; the Clouds are a good Screen against the foorching Sun-Beams, especially when the Sun paffeth

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their grand Fountain (e) the Sea; and many of them through fuch large Tracts of Land, and to fuch prodigious Distances, that it is a great Wonder the

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paffeth their Zenith; at which Time is their Winter, or coolest Season, by Reason they have then most Clouds and Rain. For which Service, that which Varene takes Notice of, is a great Providence of God, viz. Pleraque loca Zone Torride vicinumbabent mare, ut India, Insula Indica, Lingua Africa, Guinea, Brasilia; Peruvia, Mexicana, Hispania: Pauca loca Zona Torrida sunt Mediterranea: Varenii Geogr. l. 2. c. 26. Prop. 10. fect. 7.

(e) That Springs have their Origin from the Sea, and not from Rains and Vapours, among many other strong Reasons, I conclude from the Perennity of divers Springs, which always afford the same Quantity of Water: Of this Sort there are many to be found every where. But I shall for an Instance; fingle out one in the Parish of Upminster, where I live, as being very proper for my Purpose, and one that I have had better Opportunities of making Remarks upon above twenty Years: This in the greatest Droughts is little, if at all diminished; hat I could perceive by my Eye, although the Ponds all over he Country, and an adjoining Brook have been dry for many Months together; as particularly in the dry Summer Months of the Year 1705. And in the wettest Seasons, such as the Summer and other Months were, preceding the violent Storm n November 1703, (Vid. Philof. Trans. No. 289.) I fay, in fuch wet Seasons I have not observed any Increment of its Stream; excepting only for violent Rains falling therein, or running down from the higher Land into it; which discoloureth the Waters oftentimes, and makes an increase of only a Day's, or sometimes but a few Hours Continuance. But now, if this Spring had its Origin from Rain and Vapours, there would bean increase and decrease of the one, as there should happen to be of the other: As actually it is in fuch temporary Springs as have undoubtedly their Source from Rain and Vapours.

But besides this, another considerable Thing in this Upminfer Spring (and Thousands of others) is, that it breaks out of to inconfiderable an Hillock, or Eminence of Ground, that can have no more Influence in the Condensation of the Vapours, or stopping the Clouds, (which the Maintainers of this Hypothesis suppose) than the lower Lands about it have. By some Critical Observations I made with a very nice portable Barometer, I found that my House stands between 80 and 90 feet higher than the Low-Water Mark in the River of

Thames, nearest me; and that Part of the River being scarce thirty Miles from the Sea, I guess, (and am more confirmed from some later Experiments I made nearer the Sea) that we cannot be much above 100 Feet above the Sea. The Spring I judge nearly level with, or but little higher than where my House stands; and the Lands from whence it immediately issues, I guess about 15 or 20 Feet higher than the Spring; and the Lands above that, of no very remarkable Height. And indeed, by actual Measure, one of the highest Hills I have met with in Esex, is but 363 Feet high; Vid. Phil. Trans. No. 313. p. 16.) and I guess by some very late Experiments I made, neither that, nor any other Land in Essex, to be above 400 Feet above the Sea. Now what is fo inconfiderable a Rife of Land to a perennial Condenfa. tion of Vapours, fit to maintain even fo inconfiderable a Fountain, as what I have mentioned is? Or indeed the Highlands of the whole large County of Effex, to the maintaining of all its Fountains and Rivulets?

But I shall no farther prosecute this Argument, but refer to the late learned, curious and industrious Dr. Plot's Tentamen Phil'de Orig. Font. in which he hathfully discussed this Matter.

As to the Manner how the Waters are raised up into the Mountains and higher Lands, an easy and natural Representation may be made of it, by putting a little Heap of Sand, Ashes, or a little Loaf of Bread, &c. in a Bason of Water; where the Sand will represent the dry Land, or an Island, and the Bason of Water the Sea about it. And as the Water in the Bason riseth to, or near the Top of the Heap in it, so doth the Waters of the Sea, Lakes, &c. rise in the Hills. Which Case I take to be the same with the Ascent of Liquids in Capillary Tubes, or between contiguous Planes, or in a Tube filled with Ashes: Of which the industrious and compleat Artissicer in Air-Pumps, Mr. Hawksbee, hath given us some, not contemptible Experiments, in his Phys. Mech. Exp. p. 139.

Among the many Causes assigned for this Ascent of Liquors, there are two that bid the fairest for it, viz. the Pressure of the Atmosphere, and the Newtonian Attrastion. That it is not the former, appears from the Experiments succeeding, as well, or better in Vacuo, than in the open Air, the Ascent being rather swifter in Vacuo. This then being not the Cause, shall suppose the other is; but for the Proof thereof, Ishall refer to some of our late English Authors, especially some very late Experiments made before our most famous R.S. which will be so well improved by some of that illustrious Rock as to go near to nice the Matters and of least

Body, as to go near to put the Matter out of doubt.

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Fountains should be high enough (f_3) or the Seas low enough, ever to afford so long a Conveyance. Witness the Danube (g) and Wolga of Europe, the Nile (b) and the Niger (i) of Africk, the Ganges (k) and Euphrates of Afia, and the Amazons River (1) and Rio de la Plata of America, and many others which might be named; some of which are said to run above 5000 Miles, and some no less than 6000, from their Fountains to the Sea. And indeed fuch prodigious Conveyances of the Waters make it manifest, that no accidental Currents and Alterations of the Waters themselves, no Art or Power of Man, nothing less than the Fiat of the Almighty, could ever have made, or found, fo long and commodious Declivities, and Channels for the Passage of the Waters.

(f) See Book III. Chap. 4.

(g) The Danube in a soher Account, performs a Course of above 1500 Miles, (i.e. in a strait Line) from its Rise to its Fall. Bohun's Geogr. Dict.

(b) Tractus sc. Longitudo [Nili] est miliarium circiter 630 Germ. sive Ital. 2520, pro quibus ponere licet 3000 propter curvaturas. Varen. Geogr. l. 1. c. 16. p. 27.

(i) Varene reckons the Course of the Niger, at a middle

Computation, 600 German Miles, that is 2400 Italian.

(k) That of the Ganges he computes at 300 German Miles. But if we add the Curvatures to these Rivers, their Channels are of a prodigious Length.

(1) Oritur, flumen (quod plerumque Amazovum, &c.) haud procul Quito in montibus—Cum per leucas Hispanicas 1356. cursum ab occidente in orientem continuârit, ostio 84 leucas lato—in Oceanum pracipitatur. Chr. D'Acugna Relatio de flumine Amaz. in Act. Erud. Aug. 1683.



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CHAP. VI.

The great Variety and Quantity of all Things upon, and in the Terraqueous Globe, provided for the Uses of the World,

Terraqueous Globe in general is, the great Variety of Kinds, or Tribes, as well as prodigious Number of Individuals of each various Tribe, there is of all Creatures (a). There are so many Beasts, so many Birds, so many Insects, so many Reptiles, so many Trees, so many Plants upon the Land; so many Fishes, Sea-Plants, and other Creatures in the Waters; so many Minerals, Metals, and Fossils in the Subterraneous Regions; so many Species of these Genera, so many Individuals of those Species, that there is nothing wanting to the Use of Man, or any other Creature of

(a) Non dat Deus beneficia? Unde ergò ista que possides? Unde le connumerabilia, oculos, aures & animum mulcentia? Unde illa luxuriam quoque instruens copia? Neque enim necessitatibus tantummodò nostris provisum est: usque in delicias amamur. Tot arbusta, non uno modo frugisera, tot kerba salutares, tot varietates ciborum, per totum annum digesta, ut inerti quoque fortuita terra alimenta praberent. Jam animalia omnis generis, alia in sicco, & ut omnis rerum patura pars tributum aliqued nobis conferret. Senec. de Benes, l. 4. c. 5. ubi plura vide.

Hic, ubi habitamus non intermittit suo tempore Cælum nitescere, artores frondescere—tum multitudinem pecudum partim ad vescendum, partim ad cultus agrorum, partim ad vehendum, partim ad corpora vesticada; kominemque ipsum quasi contemplatorem cœli ac deorum, ipsorumque cultorem.—Hac igitur, & alia innumerabilia cum cernimus, possumusne dubitare, quin his prasit aliquis vel Essector, si hac nata sunt, ut Platoni videtur: vel si semper sucrim, ut Aristeteli placet, Moderator tami operis & muneris? Cicgr. Tusc. Quarit. l. 1. c. 48, 29.

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CHAP. VI. in the Terraqueous Globe. 5

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of this lower World. If every Age doth change its food, its way of Cloathing, its way of Building; fevery Age (b) hath its Variety of Diseases; nay, f Man, or any other Animal, was minded to change hese Things every Day, still the Creation would not be exhausted, still nothing would be wanting or Food, nothing for Physick, nothing for Building and Habitation, nothing for Cleanliness and Restessment, yea, even for Recreation and Pleasure. But the Munissicence of the Creator is such, at there is abundantly enough to supply the Vants, the Conveniencies, yea, almost the Exavagancies of all the Creatures, in all Places, all ges, and upon all Occasions,

And this may serve to answer an Objection against the Excellency of, and Wisdom shewed in, the reation; namely, What need of so many Creatues (c)? Particularly of so many Insects, so many

Plants.

⁽b) Sunt & gentium differenția non mediocres—qua contemplatio usert rursus nos ad ipsorum animalium naturas, ingenitasque vis vel vitores morborum omnium medicinas. Enim verd rerum omnium Pains, nullum animal ad hoc tantum ut pasceretur, aut alsa satiaret asci voluit: artesque salutares iis inserverit. Plin, Nat. Hist. 1, 17. C. 13.

⁽c) This was no very eafy Question to be answered by such is held. That all Things were made for Man; as most of the Ancients did; as Aristotle, Seneca, Cicero and Pliny, (to name nly some of the Chief.) And Cicero cites it as the celebrated brysippus's Opinion, Preclare enim Chrysippus, Catera nata esse Hominum Causa, Deborum. De fin. bon. & mal. 1...3. And in his de Nat. Deor. 1. 2. fin, he seriously proves the World it self to have been made for the Gods and Man, and all Things in the World to have been made and contrived for the Benefit of Man, (parata & inventa ad fructum Hominum, are his Words.) So Pliny in his Preface to his 7th Book saith, Nature made all Things for Man; but then he makes a Doubt, Whether he shewed her self a more indulgent Parent, or cruel Stephen E 4

Book II

Plants, and so many other Things? And especially of some of them, that are so far from being useful, that they are very noxious; some by their Ferity, and others by their poisonous Nature, &c.

To which I might answer, That in greater Variety, the greater Art is seen; that the sierce, poisonous, and noxious Creatures serve as Rods and Scourges to chastise us (d), as Means to excite our Wisdom, Care, and Industry, with more to the same

Mother, as in Book IV. Chap. 12. Note 2. But fince the Works of God have been more discovered, and the Limits of the Universe have been found to be of infinitely greater Extent than the Ancients supposed them; this narrow Opinion has been exploded. And the Answer will be found easy to these Questions, Why so many useless Creatures? In the Heaven, Why so many fix'd Stars, and the greatest Part of them scarce visible? Why such Systems of Planets, as in Jupin, Saturn, &c. (See may Aftro-Theology.) In the Earth and Waters, Why so many Creatures of no use to Man?

(d) Nec minùs clara exitii documenta sunt etiam ex contemnadi animalibus. M. Varro author est à cuniculis suffossum in ad Hispand opidum, à talpis in Thessalia: à ranis vivitatem in Gallia pulsam, locustis in Africa: ex Gyaro, Cycladum insula, incolas à muribus sustes; In Italia Amyclas à serpentibus delatas. Citra Cynamolgos statiopas laté deserta regio est, à scorpionibus & solopendris abactos Trerienses, author est Theophrastus. Plin. Nat. Hist. 1. 8. c. 29.

To these Instances may be added, the Plague they some times suffer from a Kind of Mice (they call Lening, Leninger, Lennus, &c.) in Norway, which eat up every green Thing. They come in such prodigious Numbers, that they fancy them to fall from the Clouds; but Ol. Magnus, rather thinks they come from some of the Islands. Hist. 1. 8. c. 2. If the Reader hath a mind to see a large Account of them, with a Dispute about their Generation, a handsome Cut of them, with the Prayers, and an Exorcism against them used in the Churchos Rome, I shall refer him, (it being too tedious to recite in these Notes) to Museum Wormian. 1. 3. c. 23.

Quare patimur multa mala à creatura quam fecit Deus, nis quis effendimus Deum?—De poena tua peccatum tuum accusa, non judicem. Nam propter Superbiam instituit Deus creaturam issam minimam & gre Ul

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from Join And Wa CHAP. VI. in the Terraqueous Globe. fame Purpose. But these Things have been fully urged by others; and it is sufficient to say, that this great Variety is a most wise Provision for all the Uses of the World in all Ages, and all Places. Some

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abjectissimam, ut ipsa nos torqueret, ut cum superbus fuerit bomo, & se jactaverit adversus Deum .- cum se erexerit. Pulicibus subdatur. Quid est, quod te inflat bumana superbia? - Pulicibus resiste, ut dormias. Cognosce qui sis. Nam propter superbiam nostram domandam creata illa qua molesta sunt : populum Pharaonis superbum potuit Deus domare de Urfis, de, Oc. Muscas & Ranas illis immisit, ut rebus vilissimis superbia domaretur. Omnia ergo per ipsum-facta funt; & fine ipfo factum eft nibil. August. Tract. 1. in S. Johan.

But although the infinitely wife Creator hath put it in the Power of such vile Animals to chastife us, yet hath he shewed no less Wisdom and Kindness in ordering many, if not most of them so, as that it shall be in the Power of Man, and other Creatures, to obviate or escape their Evils. For, befides the noble Antidotes afforded by Minerals, Vegetables, e. many, if not most of our European venemous Animals carry their Cure, as well as Poison, in their own Bodies. The Oil, and I doubt not, the Body of Scorpions too, is a certain Remedy against its Stroke. A Bee, Wasp, or Hornet, crushed and rubbed, and bound upon the Place, I have always found to be a certain Cure for the Sting of those Creatures, And I question not, but the Flesh, especially the Head, of Vipers, would be found a Remedy for their Bites.

Our Viper-Catchers have a Remedy, in which they place so great Confidence, as to be no more afraid of the Bite [of a Viper,] than of a common Puncture, immediately curing themselves by the Application of their Specifick. This though they keep a great Secret. I have upon frict Enquiry, found to be no other than Axungia Viperina, prefently rubbed into the Wound. This Remedy the learned Doctor tried himself with good Success, in a young Dog that was bitten

Vide Mead of Poysons, p. 29. in the Nose.

And as to the Means to escape the Mischief of such noxious Animals, besides what may be effected by the Care, Industry, and Sagacity of Man; some of them are so contrived and made, as to give Warning or Time to Creatures in Danger from them. Thus, for Instance, the Rattle-Snake, the most poisonous of any Serpent, who darts its poisonous Vapours to some Distance, and in all Probability was the Basilisk of the Ancients, faid to kill with its Eyes, this involuntarily gives Warning by the Rattle in its Tail. So the Shark, the most ra-

58 for Food, some for Physick (e), some for Habitation. some for Utenfils, some for Tools and Instruments of Work, and some for Recreation and Pleasure, either to Man, or to some of the inferior Creatures themselves; even for which inferior Creatures, the Liberal Creator hath provided all Things necessary, or any ways conducing to their happy, comfortable

living in this World, as well as for Man.

And it is manifest, that all the Creatures of God, Beafts, Birds, Infects, Plants, and every other Genus, have, or may have, their feveral Uses even among For although in one Place many Things may lie neglected, and out of Use, yet in other Places they may be of great Ufe. So what hath feemed ufelels in one Age, bath been received in another; as all the new Discoveries in Physick, and all the Alterations in Diet do fufficiently witness. Many Things also there are which in one Form may be pernicious to Man; but in another of great Ufe. There are many Plants (f), many Animals, many Minerals, which

pacious Animai of the Waters, is forced to turn himself on his Back, (and thereby gives an Opportunity of Escape) before he can catch his Prey.

(e) Hec sola Nature placuerat esse remedia parata vulgo, inventu facilia, ac sine impendio, ex quibus vivimus. Postea fraudes hominum & ingeniorum capture officinas invenire istas, in quibus sua cuique komini vænalis promittitur vita. Statim compositiones & misture inexplicabiles decantantur. Arabia atque India in medio astimantur, ulcerique parvo medicina à Rubro mari imputatur, cum remedia vera quetidie pauperrimus quifque exnet. Plin. 1. 24, c. 1,

Non sponte sua ex tellure germinant Herbe, que contra quoscunque morbos accommode sunt; sed ex voluntate Opificis, ad nostram utilitàtem producte sunt. Bafil. Ascet. Tom. 2.

Consult here Book X, Nota (2) (aa) (bb).

(f) Among poisonous Vegetables, none more Famous of Old than Hemlock, accounted at this Day also very dangerous to Man, of which there are some dismal Examples in our Phil, Tranf.

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CHAP. VI. in the Terraqueous Globe. in one Form destroy, in another heal. The Cafsthevery Bread of the West-Indies (g), Vipers and

Trans. Wepfer, &c. But yet this Plant is Food for Goats, and its Seeds to Bustards; and as Galen faith, to Starlings also. Nelher is this, so pernicious a Plant, only Food, but also Physick o fome Animals. An Horse troubled with the Farcy, and could not be cured with the most famed Remedies, cured imself of it in a short Time, by eating Henlock, of which he at greedily. Vid. Phil. Trans. No. 231. And a Woman which vas cured of the Plague, but wanted Sleep, did with very good Effect at Hemlock for some Time; till falling ill again of a Fever, and aving left off the Use of this Remedy, he [Nic. Fontanus] endeaoured to procure her Rest by repeated Doses of Opium, which had no peration, till the Help of Cicuta was again called in with defired uccess. Mead of Poil. p. 144.

And not only Hemlock, but many other, if not most Plants counted poisonous, may have their great Use in Medicine; of which take the Opinion of an able Judge, my ingenious nd learned Friend Dr. Tancred Robinson, in a Letter I have this to the late great Mr. Ray, of Nov. 7, 1604, viz. According my Promise, I here send you a few Observations concerning some Plants, seldom used in Medicine, being esteemed poisonous, which if trucorrected, or exactly dosed, may perhaps prove the most powerful and festual Medicines yet known. Having then given an Account f some of their Correctives, he gives these following Exmples, viz. 1. The Hellebores incorporated with a Sapo, or Alkalyalts alone, are successful Remedies in Epilepsies, Vertigo's, Palsies, Lepargies, and Mania's. Dof. a Scruple to 1 a Dram. 2. The Radic, Affari. icuta, and the Napellus, in Agues and periodical Pains, Dof, a Scruple a Dram. 3. The Hyoscyamus in Hamorrhagies, violent Heats and Perurbation of the Blood, and also in all great Inflammations. Def. a Scruple a Dram. 4. The Semen Stramonia is a very good Anodyne, ufeful in ligilia's, Rheumatisms, Hysterick Cases, in all the Orgasms of the Blood on pirits, and wherever there is an Indication for a Paregorick. Dof. a Scruple a Dram. 5. Elaterium thus corrected, may be given from gr. x. to w. in Hydropical Cases, without any sensible Evacuation or Disturbance. may the Soldanella and Gratiola in greater Doses, 6. Opium corrected s afore-mentioned, loses its Narcotick Faculty, and may be given very afely in great Doses, and proves more than usually prevalent in Convulive Cases, Fluxes, Catarrhs, and all painful Paroxysms, &c.

(g) It is of the most General Use of any Provision all over the West ndies, especially in the hotter Parts, and is used to victual Ships. 60 Variety of Things, &c. BOOK II.

and Scorpions, and many Minerals, as destructive as they are to Man, yet afford him some of his

best Medicines.

Or if there be many Things of little, immediate Use to Man, in this, or any other Age; yet to other Creatures they may afford Food or Phyfick, or be of fome necessary Use. How many Trees and Plants. nay, even the very Carcases of Animals, yea, the very Dust of the Earth (b), and the most refule, contemptible Things to be met with; I fay, how many fuch Things are either Food, or probably Medicine to many Creatures, afford them Retreat, are Places of Habitation, or Matrixes for their Generation, as shall be shewed in proper Place? The prodigious Swarms of Infects in the Air, and in the Waters, (many of which may be perhaps at present of no great Use to Man) yet are Food to Birds, Fishes, Reptiles, Insects themselves, and other Creatures (i), for whose happy and comfortable Subfistence, I have faid the Bountiful Creator hath liberally provided, as well as for that of Man.

(i) See Book IV. Chap. 11.



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Dr. Sloan's Nat. Hist. of Jamaica, Vol. 1. Ch. 5. Sect. 11. (b) I have shewn in the Philof. Trans. that the Pediculus stidicus, Mortisaga, Pulsatorius, or Death-Watch there described feedeth upon Dust; but that this Dust they eat, is powdered Bread, Fruits, or such like Dust, not powdered Earth; as manifest from their great Diligence and Curiosity in hunting among the Dust. See more in Philof. Trans. No. 291.

BOOK III.

Of the Terraqueous Globe in Particular, more especially the EARTH.

Aving thus taken a General Prospect of our Terraqueous Globe, I shall in this BOOK come to its Particulars. But here we have such an immense Variety preenting it self to our Senses, and such amazing Stroes of Power and Wisdom, that it is impossible not be at a Stand, and very difficult to know where begin, how to proceed, or where to end. But we must however attempt.

And for the more clear and regular Proceeding on this copious Subject, I shall distribute the Globe

nto its own grand constituent Parts.

I. The Earth and its Appurtenances.

II. The Waters and Theirs.

The first of these only, is what at present I shall be able to take into this Survey.

And in Surveying the Earth, I intend,

1. To consider its constituent Parts, or Things peculiar to its self.

of Creatures that have their Habitation, Growth, or Subfiftence thereon.

1. As to the Earth it self, the most remarkable Things that present themselves to our View, are,

1. Its various Moulds and Soils.

2. Its several Strata, or Beds.

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BOOK III, CHAP.

2. Its very Subterraneous Passages, Grotto's and Caverns.

4. Its Mountains and Vallies.

CHAP. I. Of the Soils and Moulds in the Earth.

THE various Soils and Moulds are an admirable and manifest Contrivance of the All-wife Creator, in making this Provision for the various Vegetables (a), and divers other Uses of the Creatures. For, as some Trees, some Plants, some Grains dwindle and die in a disagreeable Soil, but thrive and flourish in others; so the All-wife Creator hath amply provided for every Kind a proper Bed.

If some Delight in a warm, some in a cold Soil; fome in a lax or fandy, fome a heavy or clayie Soil; forme in a Mixture of both, some in this, and that,

(b) Tes

(a) It is not to be doubted, that although Vegetables delight in peculiar Soils, yet they owe not their Life and Growth to the Earth it felf, but to some agreeable Juices or Salts, &. residing in the Earth. Of this the great Mr. Boyle hath given us fome good Experiments. He ordered his Gardener to dig up, and dry in an Oven, some Earth fit for the Purpose, to weigh it, and to fet therein some Squast Seeds, (a Kind of Indian Pompion.) The Seeds when fown were watered with Rain or Spring-water only. But although a Plant was produced in one Experiment of near 3 Pounds, and in another of above 14 Pounds, yet the Earth when dried, and weighed again, was scarce diminished at all in its Weight.

Another Experiment he alledges is of Helmon's, who dried 200 Pounds of Earth, and therein planted a Willow weighing 5 Pounds, which he watered with Rain, or distilled Water: And to fecure it from any other Earth getting in, he covered it with a perforated Tin-Cover. After five Years, weighing the Tree with all the Leaves it had born in that Time, he found it to weigh 169 Pounds 3 Ounces, but the Earth to be diminished only abour 2 Ounces in its Weight. Vide Boyle's Scept. Chym. (b) Tes

Part. 2. pag. 114.

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places (b); still we find Provision enough for all hese Purposes: Every Country abounding with its proper Trees and Plants (c), and every Vegetable burishing and gay, somewhere or other about the Globe, and abundantly answering the Almighty Command of the Creator, when the Earth and Waers were ordered to their peculiar Place, Gen.i. 11. And God said, Let the Earth bring forth Grass, be Herb yielding Seed, and the Tree yielding struit after his Kind. All which we actually see so.

To this Convenience which the various Soils that pat the Earth are of to the Vegetables, we may dd their great Use and Benefit to divers Animals, many Kinds of Quadrupeds, Fowls, Insects, and leptiles, who make in the Earth their Places of lepose and Rest, their Retreat in Winter, their

Security

⁽b) Τες δε τόπες ζητεί τες δικέιες, ε μόνον τα περιττα—

εν δενδρων, &C. Τα μεν γαρ φιλεί ξηρός, τα δε ενύδρες,

ελε χειμερινες, τα δε τρος ίλλες, τα δε παλισκίες, καὶ δλως,

μεν όρεινες, τα δε ελώδεις.—Ζητεί γαρ τα πρόσφορα κατα

ν κράσιν, Έτι δε ασθενή, καὶ ισχυρά, καὶ βαθύρριζα, καὶ

ιπολαιόρριζα, καὶ ειτις άλλη διαφορά κατά τὰ μήρη—Πάντα

ερ ταῦτα, ετι δε τὰ δμοια ζητεί τὸ δμοιον, καὶ τὰ ἀνόμοια

τὸν αὐτὸν, ὅταν ἡ τις παραλλαγή τῆς φύσεως. Τheophraft.

Caus. Plant. l. 2. c. 9.

⁽c) Nec verò Terra ferre omnes omnia possunt,
Fluminibus Salicès, crassisque paludibus Alni
Nascuntur; steriles saxosis mentibus Orni:
Littora Myrtetis letissima: denique apertos
Bacchus amat colles: Aquilonem & frigora Taxi.
Aspice & extremis domitum cultoribus orbem,
Eoasque domos Arabum, pictosque Gelonos:
Divisa arberibus patria, &c. Vir. Georg. 1.2.

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Security from their Enemies, and their Nests to repose their Young; some delighting in a lax and pervious Mould, admitting them an easy Passage; and others delighting in a firmer and more solid Earth, that will better secure them against Injuries from without.



CHAP. II. Of the various Strata, or Beds, observable in the EARTH.

HE various Strata or Beds, although but little different from the last, yet will deferve a distinct Consideration.

of Minerals (a), Metals (b), Earth, and Stone (c), lying

(a) Altho' Minerals, Metals and Stones lie in Beds, and have done so ever fince Noah's Flood, if not from the Creation; yet it is greatly probable that they have Power of growing in their respective Beds: That as the Beds are robbed and emptied by Miners, so after a while they Recruit again. Thu Vitriol, Mr. Boyle thinks, will grow by the help of the Alin. So Alum doth the same. We are assured (he saith) by the expenenced Agricola, That the Earth or Ore of Alum, being robbed of its Salt, will in Tract of Time recover it, by being exposed to the An. Boyl. Suspic. about some Hid. Qual. in the Air. p. 18.

(b) As to the Growth of Metals, there is great Reason to fuspect that also, from what Mr. Boyle hath alledged in his Observations about the Growth of Metals: And in his Scept, Chym. Part 6. pag. 362. Compare also Hakewil's Apol. pag. 164.

And particularly as to the Growth of Iron, to the Instance he gives from Pliny, Fallopius, Casalpinus, and others; we may add, what is well known in the Forest of Dean in Cloudstand, what is well known in the Forest of Dean in Cloudstand, what is found there, is in the old Cinders, which they melt over again. This the Author of the Additions to Gloucesterspire, in Cambden's Brit, of the last Edition, p. 245. attributes to the Remissions of the sorter Melters, in not exhausting the Ore: But in all Probability it is rather to be attributed to the new Impregnations

CHAP (c), lying of the Hamman of

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(c), lying under that upper Stratum, or Tegument of the Earth last spoken of, all of a prodigious Use to Mankind: Some being of great Use for Building: some serving for Ornament; some surnishing as with commodious Machines, and Tools to prepare our Food, and for Vessels and Utensils, and for Multitudes of other Uses; some serving for Firing to dress our Food, and to guard us against the Inults of Cold and Weather; some being of great

f the old Ore, or Cinders, from the Air, or from fome femi-

al Principle, or plastick Quality in the Ore it self.

(c) As for the Growth of Stone, Mr. Boyle gives two Instances. One is that famous Place in France, called Les Caves outieres: Where the Water falling from the upper Parts of the Cave the Ground, doth presently there condense into little Stones, of such ligure, as the Drops, falling either severally, or upon one another and agulating presently into Stones, chance to exhibit. Nid. Scept:

Chym. p. 360.

Such like Caves as these I have my self met with in Engand; particularly on the very Top of Bredon-Hill in Worcester-tire near the Precipice, facing Perstore, in or near the old Forrefs, called Bembsbury-Camp; I faw fome Years ago fuch a Cave, which (if I mis-remember not) was lined with those talactical-Stones on the Top and Sides. On the Top they lung like Icicles great and small, and many lay on the Ground. They feemed manifestly to be made by an Exsudation, or Exstillation of some petrifying Juices out of the rocky Earth here. On the Spot, I thought it might be from the Rains baking through, and carrying with it Impregnations from he Stone, the Hill being there all rocky. Hard by the Cave is one or more vast Stones, which (if I mistake not) are incrustated with this Sparry, Stalastical Substance, if not wholly made of it. But it is so many Years ago since I was at the Place, and not being able to find my Notes about it. cannot fay whether the whole Stone is (in all Probability) Spar, (as I think it is,) or whether I found it only cased over with it, notwithstanding I was very nice in examining it then, and have now some of the Pragments by me, confisting, among other shining Parts, of some transparent angular ones.

The other Instance of Mr. Boyle, is from Linschoten, who saith, that in the East-Indies, when they have cleared the Dia-

Use in Physick, in Exchange and Commerce, in manuring and fertilizing our Lands, in dying and colouring, and ten thousand other Conveniences, too many to be particularly spoken of: Only there is one grand Use of one of these Strata or Beds, that cannot easily be omitted, and that is, those subterraneous Strata of Sand, Gravel, and laxer Earth that admit of, and facilitate the Passage of the sweet Waters (d), and may probably be the Colanders whereby they are sweetened, and then at the same Time also convey'd to all Parts of the Habitable World, not only through the temperate and torrid Zones, but even the farthest Regions of the frozen Poles.

That these Strata are the principal Passages of the sweet Fountain-Waters, is, I think, not to be doubted.

mond-Mines of all the Diamonds, In a few Years time they find in the same Place new Diamonds produced. Boyle Ibid.

(d) It is not only agreeable to Reason, but I am told by Persons conversant in digging of Wells throughout this County of Esfex, where I live, that the furest Beds in which they find Water, are Gravel, and a coarse, dark coloured Sand; which Beds feldom fail to yield Plenty of fweet Water: But for Clay, they never find Water therein, if it be a strong, slift Clay; but if it be lax and fandy, sometimes Springs are found init; yet so weak, that they will scarcely serve the Use of the smallest Family. And sometimes they meet with those Beds lying next, under a loofe, black Mould, (which, by their Description, I judged to be a fort of oazy, or to have the Resemblance of an ancient, rushy Ground,) and in that Case the Water is always naught, and stinks. And lastly, Another fort of Bed they find in Effex, in the Clayie-Lands, particularly that Part called the Rodings, which yields Plenty of sweet Water, and that is a Bed of white Earth, as though made of Chalk and white Sand. This they find, after they have dug through forty, or more Feet of Clay; and it is so tender and moist, that it will not lie upon the Spade, but they are forced to throw it into their Bucket with their Hands, or

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ofely pent te Waters pened. doubted, confidering that in them the Waters are well known to pass, and in them the Springs are ound by those that feek for them : I say, the princial Passages, because there are other subterraneous Guts and Channels, Fiffures and Passages, through which many Times the Waters make their Way.

Now that which in a particular Manner doth eem to me to manifest a special Providence of God the repositing these watery Beds is, that they hould be dispersed all the World over, into all Countries, and almost all Tracts of Land: That ey should so entirely, or for the most Part, con-It of lax, incohering Earth, and be so seldom lended with other impervious Moulds, or if they re fo, it is commonly but accidentally; and that ey are interposed between the other impervious eds, and fo are as a Prop and Pillar to guard them ff, and to prevent their finking in and thutting up e Passages, of the Waters.

The Time when those Strata were laid, was doubtis at the Creation, when God faid (Gen.i.g.) Let be Waters under the Heaven be gathered togeber unto one Place, and let the dry Land apear; or else at the Deluge, if with some sagacious laturalists, we suppose the Globe of Earth to have

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ith Bowls; but when it comes up into the Air, it foon bemes an hard white Stone.

Thus much for the Variety of Beds wherein the Waters are und. That it is in these Beds only or chiefly the Springs in, is farther manifest from the forcible Eruption of the aters sometimes out of those watery Beds. Of which see pap. 4. Note (k). This Eruption shews, that the Waters come om some Eminence or other, lying at a Distance, and being ofely pent up within the watery Stratum, by the Clayie Strata, the Waters with force mount up, when the Strata above are pened.

been dissolved by the Flood (e). At that Time (whatever it was) when the Terraqueous Globe, was in a Chaotick State, and the earthy Particles subsided, then those several Beds were in all Probability reposited in the Earth, in that commodious Order in which they now are found; and that, as is afferted, according to the Laws (f) of Gravity.

(e) Vid. Dr. Woodward's Essay, Part 2. Steno's Prodr. &c. (f) Id. ib. p. 28, and 74. But Dr. Leigh in his Nat. History Lancaphire, speaking of the Coal-Pits, denies the Strata to be according to the Laws of Gravitation, saying the Strata area Bed of Marle, afterwards Free-Stone, next Iron-Stone, then Coal or Kennel-Mine, then some other Strata, and again Coal, &c.

But upon a stricter Enquiry into the Matter, finding Ihad reason to suspect that few, if any, actually had tried the Experiment, I was minded to bring the Thing to the Test of Experiment my self; and having an Opportunity, on April, 11. 1712, I caused divers Places to be bored, laying the several Strataby themselves; which afterwards I weighed with all Strictness, first in Air, then in Water, taking Care that no Air-Bubbles, with the Accuracy of the Experiment. The Result was, that in my Yard, the Strata were gradually specifically heavier and heavier, the lower and lower they went; and the upper which was Clay, was considerably specifically lighter than the lower Stratum; which was first a loose Sand, then Gravel. In which Stratum principally the Springs run that supply my Well.

But in my Fields, where three Places were bored (to me great Depth) I found below the upper (fuperficial Stratum) and deep Bed of Sand only, which was of different Colours and Confiftence, which I weighed as before, together with the Virgin-Mould; but they were all of the fame, or nearly the fame specifick Gravity, both out of the same Hole, and out of different Holes, although the Sand was at last so gravely that it hinder'd our boring any deeper.

Upon this, fearing left fome Error might be in the former Experiments, I try'd them over again; and that with the

After this I made fome Experiments in fome deep Chalk Pits, with the Flints, Chalk, &c. above and below; but the Success was not so uniform as before.

Acquainting our justly Renowned R. S. with these Experiments, they ordered their Operator to experiment the Strate of a Coal-Pit; the Success whereof may be seen in Philip Trans. No. 336.

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CHAP. III.

Of the Subterraneous Caverns, and the Vulcano's...

Grotto's and Vulcano's, because they are made mobjection (a) against the present Contrivance and structure of the Globe. But, if well considered, hey will be found to be wise Contrivances of the Creator, serving to great Uses of the Globe, and and of God's Government. Besides many secret, rand Functions and Operations of Nature in the sowels of the Earth, that in all Probability these Things may minister unto, they are of great Use to be Countries where they are (b). To Instance in the very worst of the Things named, viz. the Vulcano's and ignivomous Mountains; although they

(a) Nemo dixerit terram pulchriorem esse quòd cavernosa sit, quòd ebiscat in multis locis, quòd disrupta caveis & spatiis inanibus; iisque ullo ordine dispositis, mulla sormà: nec que aliud contineant quam te-ebras & sordes; unde graves & pestifera exhalationes, terra motus, sc. Burnet ubi supr. c. 7.

(b) The Zirchnitzer Sea in Carniola, is of great Use to the mabitants of that Country, by affording them Fish, Fowls, sodder, Seeds, Deer, Swine, and other Beasts, Carriage for heir Goods, &c. Vid. Phil. Trans. No. 191, &c. or Lowth. Abridg. Vol. 2. p. 306, &c. where you have put together in one View, what is dispersed in divers of the Transactions. This Sea or Lake proceeds from some subterraneous Grotto, or Lake, as is made highly probable by Mr. Vakvasor, Ibid.

The Grotto Podpetschio may be another Instance, that the very subterraneous Lakes may be of Use, even to the Inhabitants of the Surface above: Of which see Lowth, ubi supr. 1. 317. Sturmius also may be consulted here in his Philos. Eclect. Exercit. 11. de Terra not. particularly in Chap. 3. some of the most eminent Specus's are enumerated, and some of their Uses.

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70 The Caverns and Vulcano's. BOOK III. they are some of the most terrible Shocks of the Globe, and dreadful Scourges of the finful Inhabitants thereof, and may ferve them as Emblems, and Prefages of Hell it felf; yet even these have their great Uses too, being as Spiracles or Tunnels (c) to the Countries where they are, to vent the Fire and Vapours that would make difmal Havock, and of tentimes actually do fo, by dreadful Successions and Conyulfions of the Earth. Nay, if the Hypothesis of a central Fire and Waters be true, these Outlets feem to be of greatest Use to the Peace and Quiet of the Terraqueous Globe, in venting the subterraneous Heat and Vapours; which, if pent up, would make dreadful and dangerous Commotions of the Earth and Waters.

It may be then accounted as a special Favour of the Divine Providence, as is observed by the Author before praised (a), "That there are scarcely any Countries, that are much annoyed with Earthquakes, that have not one of these fiery Vents. And these (saith he) are constantly all in Flames whenever any Earthquake happens, they disgorging that Fire, which whilst underneath, was the Cause of the Disaster. Indeed, (saith he,) were it not for these Diverticula, whereby it thus gaineth an Exit, 'twould rage in the Bowels of the Earth much more suriously, and make greater Havock than now it doth. So, that though those Countries, where there are such Vulcanos, are usually more or less troubled with Earth

(d) Woodward's Effay, Par. 3. Confect. 13.

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⁽c) Crebri specus [remedium] prabent. Praconceptum enim spintum exhalant: quod in certis notatur oppidis, qua minus quatiuniu, crebris ad eluviem cuniculis cavata, Plin. Hist. Nat. 1.2, c, 82.

"quakes; yet, were these Vulcano's wanting, they would be much more annoyed with them than now they are; yea, in all Probability to that Degree, as to render the Earth, for a vast Space around them, perfectly uninhabitable. In one Word, (saith he) so beneficial are these to the Territories where they are, that there do not want Instances of some which have been rescued, and wholly delivered from Earthquakes by the breaking forth of a new Vulcano there; this continually discharging that Matter, which being till then barricaded up, and imprisoned in the Bowels of the Earth, was the Occasion of very great and frequent Calamities". Thus far that ingenious Author.

CHAP. IV. Of the Mountains and Valleys.

THE last Thing I shall take Notice of relating to the Earth, shall be the Hills and Valleys. These the eloquent Theorist owns to "contain somewhat august and stately in the beholding of them, that inspireth the Mind with great Thoughts and Passions, that we naturally on such Occasions think of God and his Greatness. But then, at the same Time he saith, "The Hills are the greatest Examples of Ruin and Consusion; that they have neither Form nor Beauty, nor Shape, nor Order, any more than the Clouds in the Air; that they consist not of any Proportion of Parts, referable to any Design, nor have the least Footsteps of Art or Counsel". Consequently one grand Part of this lower Creation, even the whole present Face

of our Terraqueous Globe, according to this ingenious Author, is a Work of mere Chance, a Structure in which the Creator did not concern himself.

Part of this Charge I have already briefly answered, and my Survey now leads me to shew, that the Mountains are so far from being a Blunder of Chance, a Work without Defign, that they are a noble, ufeful, yea, a necessary Part of our Globe (a).

And in the first Place, as to the Business of Ornament, Beauty, and Pleasure, I may appeal to all Men's Senses, whether the grateful Variety of Hills and Dales, be not more pleasing than the largest continued Planes. Let those who make it their Bufiness to visit the Globe; to divert their Sight with the various Prospects of the Earth; let these, I say, judge whether the far distant Parts of the Earth would be so well worth visiting, if the Earth was every where, of an even, level, globous Surface, or

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⁽a) Though there are some that think Mountains to be a Deformity to the Earth, &c. yet if well confidered, they will be found as much to conduce to the Beauty and Conveniency of the Universe, as any of the other Parts. Nature (faith Pliny) purposely framed them for many excellent Uses; partly to tame the Violence of greater Rivers, to strengthen certain Joints within the Veins and Bowels of the Earth, to break the Force of the Sea's Inundation, and for the Safety of the Earth's libabitants, whether Beafts or Men. That they make much for the Pntection of Beasts, the Psalmist testisses, . The highest Hills are a Refuge for the wild Goats, and the Rocks for Conies. The Kingly Prophet had likewise learnt the Safety of those by his own Exprience, when he also was fain to make a Mountain his Refuge from the Fury of his Master Saul, who prosecuted him in the Wilderness. Int indeed, such Places as these keep their Neighbours poor, as being most barren, but yet they preserve them safe, as being most strong; witness our Unconquered Wales and Scotland. - Wherefore a good Author doth rightly call them Nature's Bulwarks, cast up at God Almighty's Charges, the Scorns and Curbs of victorious Armies; which made the Barbarians in Curtius, so confident of their own Safety, &c. Bishop Wilkin's World in the Moon, p. 114.

one large Plane of many 1000 Miles; and not rather, as now it is, whether it be not far more pleafing to the Eye, to view from the Tops of the Mountains the subjacent Vales and Streams, and the far distant Hills; and again from the Vales to behold the surrounding Mountains. The elegant Strains and lofty Flights, both of the ancient and modern Poets on these Occasions, are Testimonies of the Sense of Mankind on this Configuration of the Earth.

But be the Case as it will as to Beauty, which is the least valuable Consideration, we shall find as to Convenience, this Consiguration of the Earth far the most Commodious on several Accounts.

1. As it is the most salubrious, of great Use to the Preservation or Restoration of the Health of Man. Some Constitutions are indeed of so happy a Strength, and so confirmed an Health, as to be indifferent to almost any Place or Temperature of the Air: But then others are so weakly and feeble, as not to be able to bear one, but can live comfortably in another Place. With some, the finer and more subtile Air of the Hills doth best agree, who are languishing and dying in the seculent and grosser Air of great Towns, or even the warmer, and vaporous Air of the Valleys and Waters: But contrarywise others languish on the Hills, and grow lusty and strong in the warmer Air of the Valleys.

So that this Opportunity of shifting our Abode from the warmer and more vaporous Air of the Valleys, to the colder and more subtile Air of the Hills, or from the Hills to the Vales, is an admirable Easement, Refreshment, and great Benefit to the valetudinarian, seeble Part of Mankind, affording those

an easy and comfortable Life, who would otherwise live miserably, languish and pine away.

we may add another great Convenience of the Hills, and that is in affording commodious Places for Habitation: "Serving (as an eminent Author (b) wordeth it) "as Skreens to keep off the cold and "nipping Blasts of the Northern and Easterly" Winds, and reflecting the benign and cherishing "Sun-Beams, and so rendring our Habitations" both more comfortable and more chearly in "Winter; and promoting the Growth of Herbs and Fruit-Trees, and the Maturation of the Fruits in Summer.

3. Another Benefit of the Hills is, that they serve for the Production of great Varieties of Herbs and Trees (c). And as there was not a better Judge of those Matters, so I cannot give a better Account of this Convenience, than in the Words of the last cited famous Author, the late most eminent and learned Mr. Ray (d), (who hath so fully discussed this Subject I am upon, that it is scarce possible to tread out of his Steps therein.) His Observation is, "That the Mountains do especially abound with cited the subject I am upon, that it is scarce possible to tread out of his Steps therein.)

(b) Ray's Wisdom of God, &c. p. 251. Dissolution of the World,

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<sup>7. 35.
(</sup>a) Theophrastus having reckoned up the Trees that delight most in the Hills, and others in the Valleys, observeth, "Απαντα εξίσα κοινὰ τῶν ὁρῶν καὶ τῶν πεδίων, μείζω μὲν καὶ παλλίω τῆ ὁψει τὰ ἐν τοῖς πεδίοις γίνεται. κρείττω δὲ τᾶτὶ χρῶσει τῶν ξύλων καὶ τῶν καρπῶν, τὰ ὀρεινώ. Theoph. Historica τῶν ξύλων καὶ τῶν καρπῶν, τὰ ὀρεινώ. Τheoph. Historica τῶν ξύλων καὶ τῶν καρπῶν, τὰ ὀρεινώ. Τheoph. Historica καὶ μῶλλον ἐυσθενες.---Τὰ μὲν γὰς φίλει τὰς ἐφύδρα καὶ ἐλώδεις.---Τὰ δὲ, τὰς ἐυσκεπεῖς καὶ ἐυηλὶκς. Ib.l.4.6.1.
(d) Wisdom of God, p. 252.

" of the Mountains.

"different Species of Vegetables, because of the great Diversity of Soils that are found there, eve"ry Vertex or Eminence almost, affording new Kinds. Now these Plants, (faith he,) serve part"ly for the Food and Sustenance of such Animals as are proper to the Mountains, partly for medi"cinal Uses; the chief Physick, Herbs and Roots; and the best in their Kinds growing there: It be"ing remarkable, that the greatest and most luxu"riant Species in most Genera of Plants are native

4. Another Convenience which my last named learned Friend observes (e) is, "That the Moun-"tains serve for the Harbour, Entertainment, and "Maintenance of various Animals, Birds, Beasts" and Insects, that breed, feed and frequent there. "For, (saith he,) the highest Tops and Pikes of the Alps themselves are not destitute of their In-"habitants, the Ibex or Stein-buck, the Rupicapra" or Chamois, among Quadrupeds; the Lagopus among Birds. And Imy self (saith he) have ob-"ferved beautiful Papilio's, and Store of other In-"sects upon the Tops of some of the Alpine Moun-"tains. Nay, the highest Ridges of many of these Mountains, serve for the Maintenance of Cattle, "for the Service of the Inhabitants of the Valleys.

5. Another Thing he observes is, "That those long Ridges and Chains of losty and topping Mountains, which run through whole Continents East and West (f), serve to stop the Evagation of the

(e) Ubi supra.

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⁽f) Many have taken Notice, that some of the greatest Eminences of the World run generally East and West, of which take

" the Vapours to the North and South in hot Countries, condensing them like Alembick-Heads into

Water, and so (according to his Opinion) by a

"kind of external Distillation giving Original to "Springs and Rivers; and likewise by amassing,

" cooling and constipating of them, turn them into

Rain, by those Means rendring the fervid Regi-

"ons of the torrid Zone habitable.

To these might be added some other Uses and Conveniences (g); as that the Hills serve to the Generation of Minerals and Mettals (b), and that in them

take the late ingenious and learned Dr. Nichols's Account, [Confer. with a Theist, Part 2. p. 191.] To go no farther than our own Country, all our great Ridges of Hills in England run East and West; so do the Alps in Italy, and in some Measure the Pyrenees; so do the Mountains of the Moon in Africk, and so do Mount Tautus and Caucasus. This (he saith) it a wise Contrivance to present the Vapours, which would all run Northwards, and leave no Rains in

the Mediterranean Countries.

(g) That the Generation of many of the Clouds is owing to the Hills, appears from the Observations of the ingenious and learned Dr. Job. Jam. Scheuchzer of Zurich, and Mr. Joach. Frid. Creitlowius cited by him. They observed at Sun-rising, divers Clouds detatched by the Heat of the Sun, from some of the Tops of the Alps, &c. upon all which their Observations, the Conclusion is, Mirati summam Creatoris sapientiam, qui & id quod paulò antè nulli nobis usui esse videbatur, maximis rebus destinaverat, adeòque ex illo tempore dubitare cæpi, num Nubes essent sutura, si istius modi Montes & Petra non darentur. Hypothesi hac stante, elucesceret permagna utilitas, imò necessitas, quam Helviticæ Alpes non nobis tantum accolis sed & vicinis aliis regionibus prestant, dispensanda, quas gignunt Nubes, Ventos, Aquas. Scheuch. Iter. Alpin. 2. p. 20.

(b) Let us take here Ol. Mag. Observation of his Northem Mountains; Montes excelse sunt, sed pro majori parte steriles, & aridi; in quibus fere nil aliud pro incolarum commoditate & conservatione gignitur, quam inexhausta pretiosorum Metallorum ubertas, qua satis opulenti, fertilesque sunt in omnibus vita necessariis, forsitan & supersuita aliunde se libet conquirendis, unanimique robore, ac viribus, ubi vis contra hac natura dona intentata fuerit, desendendis. Acre enim genus lominum est, &c. Ol. Mag. Hist. l. 6. Præf. See also Sir Robert Sibbald's Prodr. Nat. Hist. Scot. p. 47.

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them principally are the most useful Fossiles found; or if not found and generated only in them, yet at least all these subterraneous Treasures are most easily come at in them: Also their Use to several Nations of the Earth, in being Boundaries and Bullwarks to them. But there is only one Use more that I shall

infift on, and that is,

6. And lastly, That it is to the Hills that the Fountains owe their Rise, and the Rivers their Conveyance. As it is not proper, so neither shall I here enter into any Dispute about the Origin of Springs, commonly assigned by curious and learned Philosophers. But whether their Origin be from condensed Vapours, as some think (i); or from Rains falling, as others; or whether they are derived from the Sea by way of Attraction, Percolation, or Distillation; or whether all these Causes concur, or only some, still the Hills are the grand Agent in this prodigious Benefit to all the Earth: Those vast Masses and Ridges of Earth serving as so many huge Alembicks or Cola in this Noble Work of Nature.

But be the Modus, or the Method Nature takes in this Great Work as it will, it is sufficient to my Purpose, that the Hills are a grand Agent in this so Noble and Necessary a Work: And consequently, that those vast Masses, and losty Piles, are not as they are charged, such rude and useless Excrescences of our ill-formed Globe; but the admirable Tools of Nature, contrived and ordered by the Infinite Creator, to do one of its most useful Works, and to dispense this Great Blessing to all Parts of the Earth; without which neither Animals could live, nor Vegetables

scarcely grow, nor perhaps Minerals, Metals, or Fosfiles receive any Increase. For was the Surface of the Earth even and level, and the middle Parts of its Hands and Continents, not mountainous and high, (as now it is) it is most certain there could be no Descent for the Rivers, no Conveyance for the Waters; but instead of gliding along those gentle Declivities which the higher Lands now afford them quite down to the Sea, they would stagnate, and perhaps stink, and also drown large Tracts of Land.

But indeed, without Hills, as there could be no Rivers, so-neither could there be any Fountains, or Springs about the Earth; because, if we could suppose a Land could be well watered (which I think not possible) without the higher Lands, the Waters could find no Descent, no Passage through any commodious Out-lets, by Virtue of their own Gravity; and therefore could not break out into those commodious Passages and Currents, which we every where almost find in, or near the Hills, and feldom, or never, in large and spacious Planes; and when we do find them in them, it is generally at great and inconvenient Depths of the Earth; nay, those very subterraneous Waters, that are any where met with by digging in these Planes, are in all Probability owing to the Hills, either near or far distant: As among other Instances may be made out, from the forcible Eruption of the subterraneous Waters in digging Wells, in the lower Austria, and the Territories of Modena, and Bologna in Italy, mentioned by my fore-named learned Friend Mr. Ray (k). Or if there

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⁽k) Monsieur Blundel related to the Parisian Academy, what Detice the Inhabitants of the lower Austria, (which is encompassed with

be any fuch Place found throughout the Earth, that is devoid of Mountains, and yet well watered, as perhaps some small Islands may; yet in this very Case, that whole Mass of Land is no other than as one Mountain descending, (though unperceivedly) genty down from the Mid-land Parts to the Sea, as most other Lands do; as is manifest from the Descent of their Rivers, the Principal of which in most Countries have generally their Rife in the more ofty Mid-land Parts.

And now confidering what hath been faid conerning this last Use of the Hills, there are two or hree Acts of the Divine Providence observable herein. One is, that all Countries throughout the vhole World, should enjoy this great Benefit of Mountains, placed here and there, at due and pro-

e Mountains of Stiria) are wont to use to fill their Wells with Wa-They dig in the Earth to the Depth of 25 and 20 Feet, till they me to an Argilla [clammy Earth] -which they bore through fo ep, till the Waters break forcibly out; which Water it is probable comes om the neighbouring Mountains in Subterraneous Channels. And Cafnus observed, That in many Places of the Territory of Modena and ologna in Italy, they make themselves Wells by the like Artifice &c. y this Means the same Seig. Cassini made a Fountain at the Castle Urbin, that cast up the Water 5 Feet high above the Level of the

round. Ray's Dif. r. pag. 40. ubi plura.

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Upon Enquiry of some skilful Workmen, whose Business it todig Wells, &c. whether they had ever met with the like ase, as these in this Note, they told me they had met with in Effex, where after they had dug to 50 Feet Depth, the lan in the Well observed the clayie Bottom to swell and bein to fend out Water, and stamping with his Foot to stop the Vater, he made Way for fo fuddain and forcible a Plux of Vater, that before he could get into his Bucker, he was above is Waste in Water; which foon ascended to 17 Feet height. nd there stayed: And although they often, with great Laour endeavoured to empty the Well, in order to finish their Vork, yet they could never do it, but were forced to leave it s it was,

per Distances, to afford these several Nations this excellent and most necessary Element the Waters. For according to Nature's Tendency, when the Earth and Waters were separated, and order'd to their several Places, the Earth must have been of an even Surface, or nearly so. The several component Parts of the Earth, must have subsided according to their several specifick Gravities, and at last have ended in a large, even, spherical Surface, every where equidistant from the Centre of the Globe. But that instead of this Form, so incommodious for the Conveyance of the Waters, it should be jetted out every where into Hills and Dales, so necessary for that Purpose, is a manifest Sign of an especial Providence of the Wise Creator.

vidence of God, in this Matter, is that generally throughout the whole World, the Earth is fo dispos'd, fo order'd, fo well-laid; I may fay, that the Mid-land Parts, or Parts farthest from the Sea, are commonly the highest: Which is manifest, I have said, from the Descent of the Rivers. Now this is an admirable Provision the Wise Creator hath made for the commodious Passages of the Rivers, and for draining the several Countries, and carrying of the superfluous Waters from the whole Earth, which would be as great an Annoyance, as now they are a Convenience.

Another providential Benefit of the Hills supplying the Earth with Water, is, that they are not only instrumental thereby, to the Fertility of the Valleys, but to their own also (1); to the Verdure of the

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our of the Treasures within them.

Thus having vindicated the present Form and abrick of the Earth, as distributed into Mountains nd Valleys, and thereby shewn in some Measure he Use thereof, particularly of the Mountains, thich are chiefly found Fault with: I have, I hope, ade it in some Measure evident, that God was no lle Spectator (m,) nor unconcerned in the ordering f the Terraqueous Globe, as the former bold charges against it do infer; that he did not suffer grand a Work, as the Earth, to go unfinish'd out fhis Almighty Hand; or leave it to be ordered by hance, by natural Gravity, by casual Earthquakes, c. but that the noble Strokes, and plain Remains f Wisdom and Power therein, do manifest it to be is Work. That particularly the Hills and Vales, lough to a peevish weary Traveller, they may feem incom-

rier than the Valleys; so kind Nature hath provided the eater Supplies of Moisture for them, such at least of them do not ascend above the Clouds and Vapours. For, besides e Fountains continually watering them, they have more ews and Rains commonly than the Valleys. They are more equently covered with Fogs; and by retarding, stopping, compressing the Clouds, or by their greater Colds condengthem, they have larger Quantities of Rain fall upon them. I have found by actual Experience, in comparing my Obstrations with those of my late very curious and ingenious orrespondent, Richard Townley, Esq; of Laucashire, and some thers, to be met with before, Chap. 2. Note (a). From which appears, that above double the Quantity of Rain falleth in ancashire, than doth at Upminster. The Reason of which is, ecause Lancashire hath more, and much higher Hills than Wes hath. See Book II. Chap. 5. Note (e).

(m) Accusandi sane meû sententiû bic sunt Sophista, qui cum nondum venire, neque exponere opera Natura queant, eam tamen inertiû atque sitiû condemnant, &c. Galen. de Us. Part 1. 1, 10. c. 9. incommodious and troublesome; yet are a noble Work of the Great Creator, and wisely appointed by him for the Good of our sublunary World.

And so for all the other Parts of our Terraqueous Globe, that are prefumed to be found Fault withby some, as if carelesly order'd, and made without any Defign or End, particularly the Distribution of the dry Land and Waters; the laying the feveral Strata, or Beds of Earth, Stone, and other Layers before spoken of; the Creation of noxious Animals, and poisonous Substances, the boisterous Winds; the Vulcano's, and many other Things which some are angry with, and will pretend to amend: I have before shewn, that an Infinitely Wise Providence, an Almighty Hand was concerned even in them; that they all have their admirable Ends and Uses, and are highly instrumental and beneficial to the Being, or Well-being of this our Globe, or to the Creatures residing thereon.

So also for Human Bodies, it hath been an Ancient (n), as well as Modern Complaint, that our Bodies are not as big as those of other Animals; that we cannot run as swift as Deer, fly like Birds, and that

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⁽n) Vide qu'am iniqui sint divinorum munerum astimatores, etima quidam prosessi sapientiam. Queruntur qu'od non magnitudine corpris aquemus Elephantes, velocitate Cervos, levitate Aves, impetu Tauru; qu'od solidior sit cutis Belluis, decentior Damis, denssor Ursis, nollu Fibris; qu'od sagacitate nos narium Canes vincant, qu'od acie luminum Aquila, spatio atatis Cervi, multa Animalia nandi facilitate. Etim quadam n'e coire quidem in idem Natura patiatur, ut velocitatem cuporis & vires pares animalibus habeamus; ex diversis & dissidentism bonis Hominem non esse compositum, injuriam vocant; & in negligent nostri Deos querimoniam jaciunt, qu'od non bona valetudo, & vitis in expugnabilis data sit, qu'od non futuri scientia. Vix sibi temperant qui consque impudentia provehantur, ut Naturam oderint, qu'od infra Du sumus, qu'od non in aquo illis stetimus. Seneca de Benef. lib. 2 (ap. 29.

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we are out-done by many Creatures in the Accuracy of the Senses, with more to the same Purpose. But these Objections are well answered by Seneca (0), and will receive a fuller Solution from what I shall observe of Animal Bodies hereafter.

But indeed, after all, it is only for want of our knowing these Things better, that we do not admire (p) them enough; it is our own Ignorance, Dulness or Prejudice, that makes us charge those noble Works of the Almighty, as Defects or Blun-

ders, as ill-contriv'd, or ill-made.

It is therefore fitter for fuch finite, weak, ignoant Beings as we, to be humble and meek, and conscious of our Ignorance, and jealous of our own Judgment, when it thus confronteth Infinite Wiflom. Let us remember how few Things we know. how many we err about, and how many we are gnorant of: And those, many of them, the most familiar, obvious Things: Things that we fee and handle at Pleasure; yea, our own very Bodies, and hat very Part of us whereby we understand at all, our Soul. And should we therefore pretend to cenure what God doth! Should we pretend to amend his Work! Or to advise Infinite Wisdom! Or to know the Ends and Purposes of his Infinite Will, as

(p) Naturam maxime admiraberis, si omnia ejus opera perlustraris.

Galen, de Uf. Part, l. 11, conclus,

⁽⁰⁾ Quanto satius est ad contemplationem tot tantorumque beneficioum reverti, & agere gratias, quòd nos in hoc pulcherrimo domicilio oluerunt (Dii) secundos sortiri, quod terrenis prafecerunt. Then laving reckoned up many of the Privileges and Benefits, which the Gods, he faith, have conferred upon us, he conludes, Ita est : carissimos nos habuerunt Dir îmmortales, habentque; t qui maximus tribui hovos potuit, ab ipsis proximos collocaverunt. Magna accepimus, majora non cepimus. Senec. Ibid.

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BOOK III,

if we were of his Council! No, let us bear in Mind. that these Objections are the Products, not of Reafon, but of Peevishness. They have been incommoded by Storms and Tempests; they have been terrify'd with the burning Mountains, and Earth. quakes; they have been annoy'd by the noxious A. nimals, and fatigu'd by the Hills; and therefore are angry, and will pretend to amend these Works of the Almighty. But in the Words of St. Paul (9), we may fay, Nay, but O Man, who art thou that replieft against God? Shall the Thing formed fay to him that formed it, Why haft thou made me thus? Hath not the Potter power over the Clay, of the same Lump, to make one Vessel to bonour, and another to dishonour? If the Almighty Lord of the World, had for his own Pleafure, made this our World more inconvenient for Man, it would better become us to fit still, and be quiet; to lament our own great Infirmities and Failings, which deserve a worse Place, a more incommodious Habitation, than we meet with inthis elegant, this well-contriv'd, well-form'd World; in which we find every Thing necessary for the Sustentation, Use and Pleasure, both of Man, and every other Creature here below; as well as fome Whips, some Rods to scourge us for our Sins (r)But

(9) Rom. ix. 20, 21.

⁽r) Neither are they [noxious Creatures] of less Use to amend cur Minds, by teaching us Care and Diligence, and more Wit. And so much the more, the worse the Things are we see, and should avoid Weezels, Kites, and other mischievous Animals, enduce us to a Watchfulness: Thistless and Moles to good Husbandry; Lice oblightus to Cleanliness in our Bodies; Spiders in our Houses; and the Moth in our Clothes. The Deformity and Filthiness of Swine, make them the Beauty-Spot of the Animal-Creation, and the Emblems of all Via

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But yet fo admirable well-temper'd is our State. fuch an Accord, fuch an Harmony is there throughout the Creation, that if we will but pursue the Ways of Piety and Virtue, which God hath appointed: if we will form our Lives according to the Creator's Laws, we may escape the Evils of this our frail State, and find sufficient Means to make us happy whilst we are in the Body. The natural Force and Tendency of our Virtue, will prevent many of the Harms (s), and the watchful Providence of our Almighty Benefactor, will be a Guard against others; and then nothing is wanting to make us happy, as long as we are in this World, there being abundantly enough to entertain the Minds of the most contemplative; Glories enough to please the Eye of the most curious and inquisitive; Harmonies and Conforts of Nature's own, as well as Man's making, fufficient to delight the Ear of the most harmonious and musical; All Sorts of pleasant Gusto's to gratify the Taste and Appetite, even of the most luxurious; And fragrant Odours to please the nicest and tenderest Smell: And in a Word, enough to make us love and delight in this World, rather too much, than too little, confidering how nearly we are ally'd to another World, as well as this.

Nunquam Stygias fertur ad umbras Inclyta virtus. Id. Ibid. Car. 1982.

The Truth is, Things are hurtful to us only by Accident; that is, not of Necessity, but through our own Negligence or Mistake. Houses decay, Corn is blasted, and the Weezel breeds in Mault, soonest towards the South. Be it so, it is then our own Fault, if we use not the Means which Nature and Art have provided against these Inconveniences. Grew's Cosmol. c. 2. Sect. 49, 50.

⁽s) Non est gemendus, nec gravi urgendus nece, Virtute quisquis abstulit fatis iter. Senec. Hercul. Oet. Act. 5. Car. 1833.

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BOOK IV.

Of ANIMALS in General.

TN the last BOOK, having survey'd the Earth it felf in Particular, I shall next take a View of the Inhabitants thereof; or the feveral Kinds of Creatures (a), that have their Habitation, Growth, or Subfiftence thereon.

These Creatures are either Sensitive, or Insensi-

tive Creatures.

In speaking of those endow'd with Sense, I shall confider ;

I. Some Things common to them all, II. Things peculiar to their Tribes.

I. The Things in common, which I intend to take Notice of, are these Ten:

1. The Five Senses, and their Organs.

2. The great Instrument of Vitality, Respiration.

3. The Motion, or Loco-motive Faculty of Animals.

4. The Place, in which they live and act.

5. The Balance of their Numbers.

(a) Principio cœlum, ac terras, camposque liquentes, Lucentemque globum Luna, Titaniaque aftra Spiritus intus alit, totamque infusa per artus Mens agitat molem, & magno se corpore miscet. Inde kominum, pecudumque genus, vitaque volantum, Et qua marmoreo fert monstra sub aquore pontes, Igneus est illis vigor, & cælestis origo Seminibus.

> Virgil, Eneid. L. 6. Carm. 724, 6. Their

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⁽b) Sub distinguant

6. Their Food.

7. Their Cloathing.

8. Their Houses, Nests or Habitations.
9. Their Methods of Self-Preservation.

10. Their Generation and Confervation of their Species by that Means.

CHAP. I. Of the Five Senses in General.

THE first Thing to be consider'd, in common to all the Sensitive Creatures, is, their Faculty of Seeing, Hearing, Smelling, Tasting, and Feeling; and the Organs ministring to these five Senses, together with the exact Accommodation of those Senses, and their Organs, to the State and Make of every Tribe of Animals (a). The Confideration of which Particulars alone, were there no other Demonstrations of God, is abundantly fufficient to evince the Infinite Wisdom, Power and Goodness of the Great Creator. For, who can but stand amaz'd at the Glories of these Works! At the admirable Artifice of them! And at their noble Use and Performances! For suppose an Animal, as such, had Breath and Life, and could move it felf hither and thither; yet how could it know whither to go, what it was about, where to find its Food, how to avoid thoufands of Dangers (b), without Sight! How could Man,

(b) Subjacent Oculi, pars corporis pretiosissima, & qui lucis usu vitam distinguant à morte. Plin. Nat. Hist. 1. 11. c. 37.

⁽a) Ex sensibus ante catera Homini Tactus, deinde Gustatus: reliquis superatur à multis. Aquila clarius cernunt: Vultures sagacius orderantur, liquidius audiunt Talpa obruta terra, tam denso atque surdo natura elemento. Plin. Nat. Hist. 1. 10. c. 69.

Man, particularly, view the Glories of the Heavens. furvey the Beauties of the Fields, and enjoy the Pleasure of beholding the noble Variety of divert. ing Objects; that do, above us in the Heavens, and here in this lower World, present themselves to our View every where; how enjoy this, I fay, without that admirable Sense of Sight (c)! How could also the Animal, without Smell and Tafte, distinguish its Food, and discern between wholesome and unwholsome; besides the Pleasures of delightful 0. dours, and relishing Gusto's! How, without that other Sense of Hearing, could it discern many Dangers that are at a Distance, understand the Mind of others, perceive the harmonious Sounds of Musick and be delighted with the Melodies of the winged Choir, and all the rest of the Harmonies the Creator hath provided for the Delight and Pleasure of his Creatures! And lastly, How could Man, or any other Creature distinguish Pleasure from Pain, Health from Sickness, and consequently be ableto keep their Body found and entire, without the Sense of Feeling! Here, therefore, we have a Glorious OEconomy in every Animal, that commandeth Admiration, and deserveth our Contemplation: As will better appear by coming to Particulars, and distinctly considering the Provision which the Creator hath made for each of these Senses.

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⁽c) Fæmina aliqua Megarenses solis oculis discernere valebant into Ova qua ex Gallina nigra, & qua ex alba nata sunt, is what is affirmed (how truly I know not) by Grimald, de Lumin, & Colon. Pr. 43. Sett. 60.

CHAP. II. Of the Eye.

POR our clearer Proceeding in the Confideration of this noble Part (a), and understanding its OEconomy, I shall consider:

1. The Form of the Eye.

2. Its Situation in the Body.

3. Its Motions.

4. Its Size.

5. Its Number.

6. Its Parts.

7. The Guard and Security Nature hath pro-

As this eminent Part hath not been pretermitted by Authors, that have made it their particular Defign and Business to speak of the Works of God; so divers of the aforesaid Particulars have been touched upon by them. And therefore I shall take in as little as possible of what they have said, and as near as I can, mention chiefly what they have omitted. And,

(a) In Dissectionibus anatomicis vix aliquid admirabilius, aut artificiosius structură Oculi humani, meo quadem judicio, occurrit: ut merito, per excellentiam, Creatoris appelletur Miraculum. Gul. Fabr. Hildan. Cent. 2. Observ. 1.

So likewise that accurate Surveyor of the Eye, Dr. Briggs, whose Ophthalmography I have met with since my penning this Part of my Survey. His Character of this curious piece of God's Work is, Inter pracipuas corporis animati partes, qua Magni Conditoris nostri sapientiam ostendunt, nuka sanè reperitur, qua majori pompà elucet quam ipse Oculus, aut qua elegantiori formà concinnatur. Deum enim alia partes vel minori satellitio stipantur, vel in tantam venustatem haud assurgunt; Ocelli peculiarem honerem & decus à supremo Numine essantam referunt, & nunquam non stupenda sua Potentia characteres reprasentant. Nulla sanè pars tam divino artisscio & ordine, &c. Cap, 1. Sect. 1.

1. For the Form of the Eye; which is for the most part Globous, or somewhat of the sphæroidal Form, which is far the more commogicus optical Form, as being fittest to contain the Humours within, and to receive the Images of Objects from without (b). Was it a Cube, or of any multangular Form, some of its Parts would lie too far off (c), and fome too nigh those lenticular Humours, which by their Refractions cause Vision. But by Means of the Form before-mentioned, the Humours of the Eye are commodiously laid together, to perform their Office of Refraction; and the Retina, and every other Part of that little darkned Cell, is neatly adapted regularly to receive the Images from without, and to convey them accordingly to the common Senfory in the Brain.

(b) It is a good Reason Friar Bacon assigns for the Spharicity of the Eye: Nam si esset plana figura, species rei majoris oculo mon posset cadere perpendiculariter super eum——Cum ergò Oculus vidu magna corpora, ut serè quartam cœli uno aspectu, manifestum est, quad non potest esse plana sigura, nec alicujus nisi spharica, quoniam super spharam parvam possumt cadere perpendiculares infinita, qua à magno corpore veniunt, So tendunt in centrum Sphara: Et sic magnum corpupotest ab oculo parvo videri. For the Demonstration of which he hath given us a Figure. Rog. Bacon. Perspect. Distinct. 4. Cap. 4.

Dr. Briggs faith, Pars antica, (sive Cornea,) convexior est possible kac enim ratione radii melius in pupillam detorquentur, & Oculi sundus ex altera parte in majorem (propter imagines rerum ibidem delineandos)

expanditur. Ibid. Sect. 2,

(c) Suppose the Eye had the Retina, or back part, flat for the Reception of the Images, as in Fig. 1. ABA: it is manifest, that if the Extremes of the Image AA were at a due so cal Distance, the middle B would be too night the Crystalline, and consequently appear consused and dim; but all Parts of the Retina lying at a due socal Distance from the Crystalline, as at ACA, therefore the Image painted thereon is seen distinct and clear. Thus in a dark Room, with a Lens at a Hole in the Window, (which Sturmius calls his Artificial Eye, in his Exercit. Acad. one of which he had made for his Pupils, to run any where on Wheels.) In this Room, I say, if the Paper

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To this we may add the Aptitude of this Figure to the Motion of the Eye, for it is necessary for the Eye to move this way, and that way, in order to adjust it self to the Objects it would view; so by this Figure it is well prepared for such Motions, so that it can with great Facility and Dexterity direct it self as occasion requires.

And as the Figure, fo no less commodious is,

2. The Situation of the Eye, namely, in the Head (d), the most erect, eminent Part of the Body, near the most sensible, vital Part, the Brain. By its Eminence in the Body, it is prepar'd to take in the more (e) Objects. And by its Situation in the Head, besides its Proximity to the Brain, it is in the most convenient Place for Defence and Security. In the Hands, it might indeed (in Man) be ender'd more eminent than the Head, and be turned about here and there at pleasure: But then it would be exposed to many Injuries in that active eart, and the Hands (f) render'd a less active and seful Part. And the like may be said to its Sight,

hat receives the Images be too nigh, or too far off the Lens, he Image will be confused and dim; but in the Focus of the lass, distinct, clear, and a pleasant Sight.

(g) Thus .

⁽d) Blemmyis traduntur capita abesse, Ore & Oculis pectori affixis, lin. Nat. Hist, l. 5. c. 8. Occidentem versus quosdam sine cervice dubs in humeris habentes. Ib. 1, 7. c. 2. From these, and other such like Fables, in this last cited Chapter of Pliny, no bubt our famous Romancer Sir J. Mandevile, had his Romantick Stories related in his Travels.

⁽e) See Book V, Chap. 2, Note (e),
(f) Galen descrives to be here consulted, who in his Book Usu Partium, from many Considerations of the Hand, such what is here mentioned, as also its Structure, Site and se, largely proves and restects upon the Wisdom and Prodence of the Contriver and Maker of that Part.

in any other Part of the Body, but where it is. But in the Head, both of Man, and other Animals, it is placed in a Part that feems to be contrived and made, chiefly for the Action of the principal Senses.

Another Thing observable in the Sight of the Eye, is the manner of its Situation in the Head, in the Fore-part, or Side-part thereof, according to the particular Occasions of particular Animals. In Man, and some other Creatures, it is placed to look directly forward chiefly; but withal it is so order'd, as to take in near the Hemisphere before it. In Birds, and some other Creatures, the Eyes are so seated, as to take in near a Whole Sphere, that they may the better seek their Food, and scape Dangers. And in some Creatures they are seated, so as to see best behind them (g), or on each Side, whereby they are enabled to see their Enemy that pursues them that Way, and so make their Escape.

And for the Affistance of the Eyes, and some of the other Senses in their Actions; the Head is generally made to turn here and there, and move as Occasion requires. Which leads me to the,

3. Thing to be remarked upon, the Motions of the Eye it self. And this is generally upwards, downwards, backwards, forwards, and every Way (b), for the better, more easy, and distinct Reception of the visual Rays.

But

(b) Sed lubricos Oculos fecit [Natura] & mobiles, ut & declinarent facile denverterent. Cicel. de Nat. Deor. 1. 2. c. 57.

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⁽g) Thus in Hares and Conies, their Eyes are very protuberant, and placed fo much towards the Sides of their Head, that their two Eyestake in nearly a whole Sphere: Wheres in Dogs, (that purfue them) the Eyes are fet more forward in the Head, to look that Way more than backward.

But where Nature any way deviateth from this Method, either by denying Motion to the Eyes, or the Head (i), it is a very wonderful Provision she hath made in the Case. Thus for a Remedy of this Inconvenience, in some Creatures their Eyes are set out at a Distance (k) from the Head, to be circumvolved here and there; or, one this, the other that Way, at Pleasure. And in Creatures, whose Eyes are without Motion, as in divers Insects; in this Case, either they have more than two Eyes, or their

(i) The Eyes of Spiders, (in some four, in some fix, and in some eight) are placed all in the fore-front of their Head, (which is round, and without any Neck,) all diaphanous and transparent, like a Locket of Diamonds, &c. neither wonder why Providence sould be so momalous in this Animal, more than in any other we know of. For, Since they wanting a Neck, cannot move their Head, it is requisite but Defect should be supplied by the multiplicity of Eyes. 2. Since they were to live by catching so nimble a Prey as a Fly is, they ought to see er every Way, and to take her per saltum, (as they do) without any Motion of the Head to discover her: Which Motion would have scared way so timorous an Insect. Power's Micros. Observ. p. 11.

The Eyes of the Cameleon resemble a Lens, or Convex-Glass, set in versatile globular Socket, which she turneth backward or any way, withut moving her Head; and ordinarily the one a contrary, or quite discrent way from the other. Dr. Goddard in Phil. Trans. No. 137.

But what is more extraordinary in this Motion [of the Cameleon's Eye] is to see one of the Eyes move, whilst the other remains immove-ble; and the one to turnsorward, at the same time that the other look-th behind; the one to kok up to the Sky, when the other is fixed on the Ground. And these Motions to be so extreme, that they do carry the Pupilla under the Crest which makes the Eye-brow, and so far into the Canthi, or Corners of the Eyes, that the Sight can discern whatever is done just behind it, and directly before, without turning the Head, which is sastened to the Shoulders. Mem. for a Nat. Hist. in Anatom. Dissect. at Paris. Diss. of Camel. pag. 22.

(k) Snails fend out their Eyes at a Distance, they being contained in their four Horns, like atramentous Spots, fitted to the end of their Horns, or rather to the ends of those black Filaments or optick Nerves, which are sheathed in her Horns, as Dr. Power wordeth it. Obs. 31. pag. 36. So the ingenious Dr. Lister, Exercit. Anat.

Cochl. & Limao.

their Eyes are nearly two protuberant Hemispheres, and each Hemisphere often consisting of a prodigious Number of other little Segments of a Sphere (1). By which Means those Creatures are so far from being deny'd any Benefit, of that noble and most necessary Sense of Sight, that they have probably more of it than other Creatures, answerable to the Rapidity of their Flight, and brisk Motion; and to their Inquests after Food, Habitation, or Repositoties of Generation, or such other Necessity of the Animal.

4. Another admirable Provision in the Eye, is, its Size; in some Animals large, in some little. It would be endless here to enumerate Particulars; as those of Quadrupeds, Birds, Insects, and other terrestrial Animals. And as for Fishes, they will fall under another Part of my Survey.

I shall therefore only take Notice of its Size in one Creature, the Mole (m). As the Habitation of

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(1) Vid. 1. 8. c. 3. Note (a).

Et quoniam Natura boc vita genus ipsi destinavit, etiam perquam exiguos Oculos—dedit eo concilio, ut ii, pretiosissima corporis pars, a terra pulvere ne affligerentur. li insuper pilis tetti, &c., Humores illis oculis insunt, & tunica nigra, uvea, se prodit. Ad hos tramite alio nervus venit. Schneider in Blas. ibid.

Some time fince I made divers accurate Diffections of the Eyes of Moles, with the help of Microscopes, having a doubt whether what we take to be Eyes, were such or no. And upon

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⁽m) Soverinus is cf Aristotel's, Pliny's, and Alb. Magnus's Opinion, that the Mole hath no Sight; G. Seger denies any Humour to be therein, but thinks they may probably see, be cause Nature made nothing in vain. But Borrichius saith, their Eyes have appendiculam nerveam in cerebrum euntem, cujus benefico globuli illi [the little Eyes] extra pellem facile poterant exseri, retabique pro arbitrio——In illis oculorum globulis humor aqueus copiois satis natabat; caterorum non nisi tenue vestigium. Blas. Anat. Anim. c. 35.

that uncouth Animal is wholly subterraneous, its Lodging, its Food, its Exercises, nay even all its Pastimes and Pleasures, are in those subterraneous Recesses and Passages, which its own Industry hath made for it felf; so it is an admirable Provision made in the Size of the Eye of that little Creature. to answer all its Occasions, and at the same Time to prevent Inconveniences. For as a little Light will suffice an Animal living always under Ground, fo the smallest Eye will abundantly supply that Occasion. And as a large protuberant Eye, like that of other Animals, would much annoy this Creature in its principal Business, of digging for its Food and Passage; so it is endowed with a very small one, commodiously seated in the Head, and well fenced and guarded against the Annoyances of the Earth.

5. Another Thing remarkable in this noble Part of Animals, is, its Numbers; no less than two (n)

upon a strict Scrutiny I plainly could distinguish the Virreous and Crystalline Humours, yea, the Ligamentum Ciliare, and the atramentaceous Mucus. The Pupil I could manifestly discern to be round, and the Cornea copped, or conical: The Eye is at a great distance from the Brain, the Optick Nerve very slender and long, reaching from the Eye through the intermediate Flesh, and so passet to the Brain, along with the pair of Nerves reaching to the Nose, which are much the largest that are in all the Animal. These Creatures, I imagine, have the Faculty of withdrawing their Eyes, if not quite into the Head, (as Snails) yet more or less within the Hair, as they have more or less Occasion to use or guard their Eyes.

Galen faith, Moles have Eyes, the Crystalline and Vitreous Humours, encompassed with Tunicks. De Us. Part. 1. 14. c. 6.

So accurate an Anatomist was he for his Time.

(n) Pliny tells us, of a Sort of Heron with but one Eye, but it was only by Hear-say. Inter Aves Ardeolarum gener, quos Leu-

in any Instance, that I know of; and in some Animals more, as I have already hinted (0).

Now this is an admirable Provision; first, for the Convenience of taking in the larger Angle, or Space: And in the next Place, the Animal is by this Provision, in some Measure, prepared for the Missortune of the Loss of one of these noble, and necessary Organs of its Body.

But then besides all this, there is another Thing considerable in this multiplicate Number of the Eye; and that is, that the Object seen is not multiplied as well as the Organ, and appears but one, though seen with two or more Eyes (b). A manifest Sign

the King of the Nigra that hath but one Eye, and that in his Forehead. 1. 6. c. 30. Which Fables I take Notice of more for the Reader's Diversion, than any Truth in them.

(o) Suprà, Note (i).

(p) The most celebrated Anatomists differ greatly about the Reason, why we see not double with two Eyes. This Galen, and others after him, generally thought to be from a Coalition or Decussation of the Optick Nerves, behind the Os Spheneides. But whether they decussate, coalesce, or only touch one another, they do not well agree. The Bartholmus expressly affert, they are united, Non per simplicem contactum vil intersectionem in homine, sed totalem substantia consusceme. Anat. 3. c. 2. And whereas Vesalius, and some others, had sound some Instances of their being distunited; they say, Sed in perisque ordinare consunditur interior substantia, ut accurata disquisition deprehendi.

But our Learned Dr. Gibson, (Anat. 1. 3. c. 10.) faith, they are united by the closest Conjunction, but not Consustion of their Fibres.

But others think the Reason is not from any Coalescence, Contact, or crossing of the Optick Nerves, but from a Sympathy between them. This Monsieur Cartes is of Opinion, That the Fibrille, constituting the medullary Part of those Nerves, being spread in the Retina of each Eye, have each of them corresponding Parts in the Brain; so that when any of those Fibrella are struck by any Part of an Image, the

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of the infinite Skill of the Contriver of this fo noble a Part, and of the exquisite Art he employed in the Formation thereof. But the Defign and Skill of the

Infinite Workman, will best be set forth by.

6. Surveying the Parts and Mechanism of this admirable Organ the Eye. And here indeed we cannot but stand amazed, when we View its admira-

corresponding Parts of the Brain are thereby affected, and the Soul thereby informed, &c. But see more hereaster

under Note (00), from Cartes himself.

Somewhat like this is the Notion of our judicious Dr. Briggs, who thinks the Optick Nerves of each Eye confift of Homologous Fibres, having their rife in the Thalamus Nervorum Opticorum, and thence continued to both the Retine, which are made of them: And farther, that those Fibrilla have the same Parallelism, Tension, &c. in both Eyes; and consequently when an Image is painted on the fame corresponding, fympathizing Parts of each Retina, the fame Effects are produced, the same Notice or Information is carried to the Thalamus, and fo imparted to the Soul, or judging Faculty. That there is fuch an 'Ouotoraloua between the Retina, &c. he makes very probable, from the ensuing of double Vision upon the Interruption of the Parallelism of the Eyes; as when one Eye is depressed with the Finger, or their Smphony interrupted by Disease, Drunkenness, &c. And lastly, That simple Vision is not made in the former Way, viz. by a Decustation or Conjunction of the Optick Nerves, he proves, because those Nerves are but in few Subjects decussated, and in none conjoined otherwise than by a bare Contact, which is particularly manifest in Fishes; and in some Instances it hath been found, that they have been separated without any double Vision ensuing thereupon. Vide Brig. Ophthalmogr. cap. 11, & 5. and Nov. Vis. Theor. Passim.

What the Opinion of our justly eminent Sir Isaac Newton is, may be seen in his Opticks, Qu. 15. Are not the Species of Objects seen with both Eyes, united where the Optick Nerves meet before they come into the Brain, the Fibres on the right Side of both Nerves uniting there, &c. For the Optick Nerves of such Animals as look the same Way with both Eyes, (as of Men, Dogs, Sheep, Oxen, &c.) meet before they come into the Brain; but the Optick Nerves of juch Animals as do not look the same Way with both Eyes, (as of Fishes, and of the Cameleon) so not meet, if I am rightly informed. Newt. Opt. Q. 15.

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ble Fabrick, and confider the prodigious Exactness, and the exquisite Skill employed in every Part ministring to this noble and necessary Sense. To pass by its Arteries and Veins, and fuch other Parts common to the rest of the Body, let us cast our Eve on its Muscles. These we shall find exactly and neatly placed for every Motion of the Eye. Let us view its Tunicks, and these we shall find so admirably leated, so well adapted, and of so firm a Texture, as to fit every Place, to answer every Occafion, and to be Proof against all common Inconveniences and Annoyances. Let us examine its three Humours, and these we shall find all of exquisite Clearness and Transparency, for an easy Admission of the Rays; well placed for the refracting of them, and formed (particularly the Crystalline Humour) by the nicest Laws of Opticks, to collect the wandring Rays into a Point. And to name no more, let us look into its darkned Cell, where those curious Humours lie, and into which the Glories of the Heavens and the Earth are brought, and exquisitely pictured; and this Cell we shall find, without, well prepared by Means of its Texture, Aperture, and Colour, to fence off all the useless or noxious Rays; and within, as well coated with a dark Tegument, that it may not reflect, diffipate, or any way confuse or disturb the beneficial Rays (q).

(q) Nigra est [Uvea] ut radios (ab Oculi fundo ad anterioremejus partem reflexos) obumbret; ne bi (ut ait clar. Cartefus) ad Oculi fundum retorti ibidem confusam vistonem efficerent. Alia forsan ratio bujus nigredinis statuatur, quod radii in visiono superstui, qui ab objectis lateralibus proveniunt hoc ritu alsorbeantur. Ita enim è loco obsenso interdis objecta optime intremur, quia radii turc temporis circumfus luming non dilumitur. Brigg's Ophthal. c. 3. fect. 5.

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But to descend to Particulars, although it would be a great Demonstration of the Glory of God, yet would take up too much Time, and hath been in some Measure done by others that have written of God's Works. Passing over therefore what they have observed, I shall under each principal Part take a transient Notice of some Things they have

omitted, or but flightly spoken of.

And my first Remark shall be concerning the Muscles of the Eye, and their Equilibration. Nothing can be more manifestly an Act of Contrivance and Design, than the Muscles of the Eye, admirably adapted to move it any, and every way; upwards, downwards, to this Side or that, or howfoever we please, or there is Occasion for, so as to always keep that Parallelism of the Eye, which is necessary to true Vision. For the Performance of which Service, the Form, the Position, and the due Strength of each Muscle is admirable. And here Imight Instance the peculiar and artificial Structure of the Trochlearis, and the Augmentation of its Power by the Trochlea (r); the Magnitude and Strength of the Attollent Muscle, somewhat exteeding that of its Antagonist; the peculiar Muscle, called

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[Museulum Trochlearem] per intermedium trochleam traducum, nunquam intucor, quin admirabundus mecum, O Gede, exclamen, v perov del yesquetpel, dand nal del pnynvatates I. C. Sturmit Exercit. Acad, 9. de Vis. Org. & Rat. c. 3. Self. 4: p. 446.

⁽r) Admirandum Dei artificium ex diversorum animalium compaatione indies evadit manifestiùs. Mirantur omnes Trochlearem in culis Hominum & Quadrupedum, & quidem jure: sed admirationem mnem superat, quòd sine Trochlea oculum movens in Avibus novum enus Trochlea longè artificiosiùs Nictitandi Membrana dederit. Blas. Anat. Animal. p. 2. c. 4. ex Stenon.

called the Seventh, or Suspensory Muscle (s), given to Brutes, by reason of the prone Posture of their Bodies, and frequent Occasions to hang down their Heads: And I might speak also of the peculiar Origin and Insertion of the lower Oblique Muscle (t), which is very notable, and many other Things relating to these Parts; but it would be tedious to descend too much to those admirable Particulars. And therefore to close up these Remarks, all I shall farther take Notice of, shall be only the exquisite Equilibration of all these Opposite and Antagonists Muscles,

Of this Opinion also was Bartholine, Anat. 1. 3. c. 8. and di-

vers other eminent Anatomists.

But Dr. Briggs is of Opinion that the Adnata, and the other Muscles sufficiently answer all those Ends ascribed to that Muscle by former Anatomists, and thinks Probabilities itaque esse buns Musculum nervi Optici actionem (per vices) confirmare, ne à prono Brutorum incessu & copusso affluxu humorum debiliretur. Ophthal. c. 2. sect. 2.

The Musculus Suspensorius being in the Porpess, as well as Brutes, Dr. Tyson thinks the Use of it is not to suspend the Bulk of the Eye; but rather by its equal Contraction of the Solerotis, to render the Ball of the Eye more or less Spherical, and so fitter for Vision. Tyson's Anat. of the Porpess, p. 39.

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⁽s) Observare est quod Quadrupedes, qui oculos in terram pronos, as pendulos gerunt, Musculum peculiarem habent, quo Oculi globus suspenditur—Hoc Musculo Bos, Equus, Ovis, Lesus, Porcus, &c. praditisunt: hoc etiam Canis instruitur, sed alio modo conformatum habet. Willis de An. Brut. p. 1. c. 15.

⁽t) Musculus obliquus inserior oritur à peculiari quodam foramine in latere Orbita ocularis facto, (contra quam in cateris, &c.) quo sit ut ex una parte à Musculo trochleari, ex altera verò ab bujus Musculi commodissima positione, Oculus in aquilibrio quodam constitutus, irretori obtutu versus objecta feratur, nec plus justo accedat versus internum externum ve canthum; qua quidem Libratio omnino nulla suisset, absqui bujus Masculi peculiari originatione (cujus ratio omnes hucusque Anatomicos latuit.) And so this curious Anatomist goes on to shew farther the stupendous Artisice of the Great Creator in this Position of the Oblique Muscles. Brigg's Nova Vis. Theor.

Muscles, affected partly by the Equality of the Strength; which is the Case of the Adducent and Abducent Muscles; partly by their peculiar Origin, or the Addition of the Trochlea, which is the Case of the Oblique Muscles (u); and partly by the natural Posture of the Body, and the Eye, which is the Case of the Attollent and Depriment Muscles. By this so curious and exact a Libration, not only unseemly Contortions, and incommodious Vagations of the Eye are prevented, but also it is able with great Readiness and Exactness to apply it self to every Object.

As to the Tunicks of the Eye, many Things might be taken notice of, the prodigious Fineness of the Arachnoides, the acute Sense of the Retina, the delicate Transparency of the Cornea (w), and the firm and strong Texture of that and the Sclerotica too; and each of them, in these and every other respect, in the most accurate Manner adapted to the Place in which it is, and the Business it is there to

perform.

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⁽u) Besides those particular Motions which the Eye receives from the Oblique Muscles, and I may add its Libration also in some Measure, some Anatomists ascribe another no less considerable Use to them; namely, to lengthen and shorten the Eye (by squeezing and compressing it) to make it correspond to the Distances of all Objects, according as they are nigh or far off. Thus the ingenious Dr. Keil; The Aqueous Humour being the thinness and most liquid, easily changeth its Figure, when either the Ligamentum Ciliare contracts, or both the Oblique Muscles squeeze the middle of the Ball of the Fye, to render it Oblong when Objects are too near us. Keil's Anat. Chap. 4. Sect. 4. See Note (y).

⁽w) Quis verò opifex prater Naturam, qua nibil potest esse callidius, tantam solertiam persequi potuisset in Sensibus? qua primum Oculos membranis tenuissimis vestivit, & sepiit; quas primam persucidas secit, ut per eas cerni posset: sirmas autem, ut continerentur. Cic. de Nat. Deor. 1. 2. c. 57.

BOOK IV.

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perform. But for a Sample, I shall only take No. tice of that Part of the Uvea which makes the Pn. pil. It hath been observed by others, particularly by our Honourable Founder (x), That as we are forced to use various Apertures to our Optick Glasses, so Nature hath made a far more compleat Provision in the Eyes of Animals, to shut out too much, and to admit sufficient Light, by the Dilatation and Contraction of the Pupil (v). But it deferveth our especial Remark, that these Pupils are in divers Animals of divers Forms, according to their peculiar Occasions. In some (particulary in Man) it is round; that being the most proper Figure for the Position of our Eyes, and the Use we make of them both by Day and Night. In some other Animals, it is of a longish Form; in some Transverse (2), with its Aperture large, which is an admirable

(x) Boyle of Final Causes.

(z) In Bove, Capra, Equo, Ove, & quibusdam aliis elliptica est (Pupilla) ut eo magis in hisce for san animalibus, que prono incessu victum in agris quaritant, radios laterales ad mala & incommeda utrinque devitanda admittat. Briggs's Opthal. c. 7. fect. 6.

Homini erecto, aliifque, &c. caput erigere, & quaquaversus circumspicere solitis, plurima simul objecta, tum supra, tum infra, tum è latere utroque-visu excipiuntur ; quapropter Oculi Pupilla votunda effe Achet .- Attamen boyi, &c. caput fere semper pronum gerentibu,

⁽y) It is easy to be observed, that the Pupil openeth in dark Places; as also when we look at far distant Objects, but contracts by an Increase of Light, and when the Objects are nigh. This Motion of the Pupil some say, is effected by the circular and strait Fibres of the Uvea, and some attribute it to the Ligamentum Ciliare. Yet I have no great doubt but that they both concur in that Action, and that the Ligamentum Ciliare doth, at the fame Time the Pupil opens or shuts, dilate or compress the Crystalline, and bring it nigher unto, or carry it farther off the Retina. For the Structure of the Ligamentum Ciliare, and its two Sorts of Fibres, drawn with the Help of a Microscope, I shall refer to Mr. Cowper's Anat. T. 11.

mirable Provision for such Creatures to see the better laterally, and thereby avoid Inconveniencies, as well as help them to gather their Food on the Ground, both by Day and Night. In other Animals the Fissure of the Pupil is erect (aa), and also capable of opening wide, and shutting up close. The latter of which serves to exclude the brighter Light of the Day, and the former to take in the more faint Rays of the Night, thereby enabling those Nocturnal Animals (in whom generally this erect Form of the Pupil is) to catch their Prey with the greater Facility in the Dark (bb), to see upwards and downwards, to climb, &c. Thus much for the Tunicks.

tantum que coram, & paulo à latere obversantur, intuitu opus est : quapropter Pupilla—oblonga est, &c. Willis de Anim. Brut. p. 1. c. 15.

(aa) Thus Cats (their Pupils being erect, and the shutting of their Eye-lids transverse thereunto) can so close their Pupil, as to admit of, as it were, one only single Ray of Light; and by throwing all open, they can take in all the faintest Rays. Which is an incomparable Provision for these Animals, that have Occasion to watch and way-lay their Prey

both by Day and Night.

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(bb) There is besides this large opening of the Pupil, in some Nocturnal Animals, another admirable Provision, enabling them to catch their Prey in the Dark; and that is a Radiation of the Eyes: Of which Dr. Willis thus; Hujus usus oft Oculi Pupillam, quasi jubare insito, illuminare, ut res notu, on tenebris positas conspicere valeat: quare in Fele plurimum illustris oft at Homini, Avibus of Piscibus doost. This Illumination he speaks of, is from the Tapetum, in the Bottom of the Eye, or the shining of the Retina, round the Optick Nerve.

Besides which, he saith, the Iris hath a Faculty also, in some, of darting out Rays of Light, so as to enable them to see in the Dark: Of which he tells this Story; Novi quendam cerebro calidiori praditum, qui post uberiorem vini generosi potum in note atrata, sive tenebris profundis, literas distincte legere potuit. Cuins ratio videtur esse, quod spiritus animales velut accense, adcoque ab haclide irradiantes, jubare insito Medium illuminabant. Willis Ibid.

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The next Thing I shall take Notice of, will relate to the Humours of the Eye, and that only concerning the Mechanism of the Crystalline Humour; not its incomparable Transparency; nor its exact lenticular Form; nor its curious araneous Membrance (cc), that constringeth and dilateth it, and

Such another Thing, Pliny tells us, was reported of Tiberius Casar; Ferunt Tib. Cas. nec alii genitorum mortalium, suisse naturam, ut expergesatus noctu paulisper, haud alio modo quam luce clarâ, contueretur omnia. Nat. Hist. 1. 11. c. 37.

So Dr. Briggs; Virum sanè calida indolis novi in Comitatu Belfordiensi degentem, qui oculis felineis—donatus est: adeo ut epistolam mire admodum in loco obscuro (ubi eadem mihi vix apparuit) perlegit. Hujus vero Oculi (nist quod Pupillas insigniores obtinuere) ab aleorum formatione neutiquam discrepabant. Ophthal. c. 5. sect. 12.

(cc) The Tunica Aranea is taken Notice of by Friar Bacon, who calls it, Tela Aranea, and faith, in hac continetur-glaciale vel Crystallinum. Rog. Bacon's Perspect. Distinct. 2. c. 3. The wrinkling of this, and the Cornea (as the Skin is of old Persons) he thinks is the Cause of the Obscurity of the Sight in such Persons. Bacon Ib. par. 2. c. 2. But this Tunick some deny, and others allow of; Dr. A. M. of Trinity-College, Dublin, (in his Relat. of Anat. Obs. in the Eyes of Animals, in a Letter to Mr. Boyle, Ann. 1682. annexed to his Anat. Account of the Elephant burnt in Dublin, p. 57.) affirms the Tunica Aranea, and faith, I have often seen it before 'twas exposed to the Air one Minute, notwithstanding what Dr. Briggs saith to the contrary, &c. But Dr. Briggs his Opinion is, Humor Crystallinus, nist aeri diutius expositus, vel leniter coctus (inftar lactis) cuticulam non acquirit : que vero improprie, Tunica Aranea dicitur, cum si tantum adventitia, ut in Oculo Bovis recens exetto appareat. Briggs's Opthalm. c. 3.

The Crystalline Humour being of a double Substance, outwardly like a Jelly, towards the Centre as confistent as hard Suet, upon occasion whereof its Figure may be varied; which Variation may be made by the Ligamentum Ciliare; Dr. Grew doth, upon these Accounts, not doubt to ascribe to the Ligamentum Ciliare, a Power of making the Crystalline more Convex, as well as of moving it to, or from the Retina. See Grew's Cosmolog. Sacr. 1. 1. c. 4. Now it is certain by the Laws of Opticks, that somewhat of this is absolutely necessary to distinct Vision, inasmuch as the Rays proceeding from night Objects do more diverge, and those from distant Objects less:

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(dd) fo in fo fpond t fo varieth its Focus, (if any fuch Variation there be, as some affirm with great Probability,) nor lastly, its admirable Approach to or from the Retina, by help of the Ciliar Ligament (dd), according as Objects

less: Which requires either that the Crystalline Humour should be made more Convex, or more flat; or else an Elongation, or shortning of the Eye, or of the Distance between the Cry-

stalline Humour and the Retina.

But although Dr. Briggs (so good a Judge) denies the Tunica Crystallina, contrary to the Opinion of most former Anatomists; yet there is great Reason to conclude he was in a Mistake, in my Opinion, from the Observations of the French Anatomists, of the Crystalline of the Eye, of the Gemp or Chamois, who say, The Membrana Arachnoides was very thick, and hard, so

that it was easily separated from the Crystallinus, p. 145.

The same Anatomists also favour the Surmise of Dr. Grew. This [Contraction of the Fibres of the Ligamentum Ciliare on one side, and Dilatation on the other] would make us think that these Fibres of the Ligamentum Ciliare, are capable of Contraction, and voluntary Dilatation, like that of the Fibres of the Muscles; and that this Action may augment, or diminish the Convexity of the Crystallinus, according as the Need which the Distance of the Objects may make it to have on the Eye, to see more clearly and distinctly. Anat.

Descrip. of a Bear, p. 49.

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Since my penning the foregoing Notes, having as critically as I could, diffected many Eyes of Birds, Beasts and Fishes, I manifestly found the Membrana Arachnoides, and will undertake to shew it any one, with great Ease and Certainty. It is indeed so transparent, as not to be seen distinct from the Crystalline. But if the Cornea and Uvea be taken off before, or the vitreous Humour behind it, and the out-side of the Crystalline be gently cut, the Arachnoïdes may be seen to open, and the Crystalline will easily leap out, and part from the Ligamentum Ciliare; which otherwise it would not do: For it is by the Arachnoïdes braced to the Ligamentum Ciliare. This Membrane or Tuniek, in the Ox, is so substantial and strong, though thin, that it yields to, or sinks under the sharpest Lancet, and requires (for so thin and weak a Membrane in Appearance) a strong Pressure to pierce it.

(dd) As Birds and Fishes are in divers Things conformable, so in some Sort they are in their Eye; to enable it to correspond to all the Convergences, and Divergences of the Rays,

Objects are far off or near, because these Things are what are usually taken notice of; but that which

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which the Variations of each of the Mediums may produce. For this Service the Tunica Chorocides, (in Fishes) hath a musculous Substance at the Bottom of it, lying round the Optick Nerve, at a small Distance from it; by which Means I imagine they are able to contract, and dilate the Chorocides, and thereby to lengthen and shorten the Eye: For the helping in which Service, I imagine it is that the Chorocides, and Scientica, are in a great Measure parted, that the Chorocides may have the greater Liberty of acting upon the Humours within.

But in Birds, I have my felf found, that although the Ok. voeides be parted from the Sclerotica; yet the Chorocides hath no Muscle, but instead thereof, a curious pectinated Work, seated on the Optick Nerve, represented in Fig. 2. In which c. a.t. b. d. represents the Chorocides and Sclerotica; a. b. the Part of the Optick Nerve, that is within the Eye; v. v. v. the vitreous Humour; a. f. g. b. the Pecten; b. i. the Crystalline. For the Reception of this Petten, the Optick Nerve comes farther within the Eye, than in other Creatures. The Structure of this Petten, is very like that of the Ligamentum Ciliare; and in the Eye of a Magpye, and some others, I could perceive it to be musculous towards the Bottom. This Petten is fo firmly fixed unto, or embodied in the vitreous Humour, that the vitreous Humour hangs firmly to it, and is not fo eafily parted from it. By which Means all the Motions of the Petten are easily communicated to the vitreous Humour, and indeed to all contained in the Choroeides. And forafmuch as the Crystalline is connected to the vitreous Humour, therefore also the Alterations in the vitreous Humour affect also the Crystalline; and the Cry stalline is hereby brought nearer unto, or farther from the Retina, as Occasion is.

Besides all which Observables in the Chorocides, and inner Eye, I have also found this farther remarkable in the Sclerotica, and outer-part of the Eye of Birds, viz. That the fore-part of the Sclerotica is horny and hard, the middle-part thin and flexible, and Braces intervene between the fore and hind-part, running between the Chorocides and Sclerotica; by which Means the Cornea, and back-part of the Eye, are brought to the

same Conformity, that the rest of the Eye hath.

The great End and Defign of this fingular and curious Apparatus in the Eyes, both of Birds and Fishes, I take to be, r. To enable those Creatures too see at all Distances, far off,

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I shall observe is, the prodigious Art and Finery of its constituent Parts, it being, according to some late nice Microscopical Observations (ee), composed of divers thin Scales, and these made up of one single

or nigh; which (especially in the Waters) requireth a different Conformation of the Eye. In Birds also, this is of great Use, to enable them to see their Food at their Bill's End, or to reach the utmost Distances their high Flights enable them to view; as to fee over great. Tracts of Sea or Land, whither they have Occasion to fly; or to see their Food or Prey, even small Fishes in the Waters, and Birds, Worms, &c. on the Earth, when they fit upon Trees, high Rocks, or arc hovering high in the Air. 2. To enable those Animals to adapt their Eye to all the various Refractions of their Medium. Even the Air it felf varies the Refractions, according as it is rarer or denfer, more or less compressed; as is manifest from the learned and ingenious Mr. Lowthorp's Experiment in Phil. Trans. No. 257. and some other Experiments since of the before-commended Mr. Hawksbee, both in natural, rarify'd and compressed Air; in each of which, the Refractions con-fantly varied in exact Proportion to the Rarity or Density of the Air. Vid. Hawksbie's Exp. p, 175, &c.

Besides this Conformity in general, between the Eyes of Birds and Fishes, Du Hamel tells us of a singular Conformity in the Cormorant's Eye, and that is, that the Crystalline is globous, as in Fishes, to enable it to see and pursue its Prey under Water: Which F. Faber, in Mr. Willughby saith, they do with wonderful Swiftness, and for a long Time. Will. Ornithol. p. 329.

(ee) The Crystalline Humour, when dry'd, doth manifestly enough appear to be made up of many very thin spherical Lamine, or Scales lying one upon another. Mr. Lewenboek reckons there may be two thousand of them in one Crystalline, from the outermost to the Centre. Every one of these Scales, he saith, he hath discovered to be made up of one single Fibre, or finest Thread wound, in a most stupendous Manner, this Way, and that Way, so as to run several Courses, and meet in as many Centres, and yet not to interfere, or cross one another, in any one Place. In Oxen, Sheep, Hogs, Dogs and Cats, the Thread spreads into three several Courses, and makes as many Centres: In Whales sive; but in Hares and Rabbets only two. In the whole Surface of an Ox's Crystalline, he reckons there are more than twelve thousand Fibres juxtaposited. For the right and clear Understanding of the Manner of

fingle minutest Thread or Fibre, wound round and round, so as not to cross one another in any one Place, and yet to meet, some in two, and some in more different Centres; a Web not to be woven. an Optick Lens, not to be wrought by any Art

less than Infinite Wisdom.

Laftly, To conclude the Parts of this admirable Organ, I shall make only one Remark more, and that is about its Nerves. And here, among others, the admirable Make of the Optick Nerves might deserve to be taken Notice of in the first Place, their Medullary Part (ff) terminating in the Brain itself, the Teguments propagated from the Meninges, and terminating in the Coats of the Eye, and their commodious infertions into the Ball of the Eye, in some directly opposite to the Pupil of the Eye, in others obliquely towards one Side (gg). But most of these Things have been treated of, and the Convenience hereof fet forth by others that have written of

which admirable Piece of Mechanism, I shall refer to his Cuts and Descriptions in Philos. Trans. No. 165, and 193. The Truth hereof I have heard fome ingenious Men question; but it is what I my felf have feen, and can shew to any Body, with the Help of a good Microscope.

(ff) S. Malpighi observed the Middle of the Optick Nerve of the Sword-Fift, to be nothing else but a large Membrane, folded according to its Length in many Doubles, almost like a Fan; and invested by the Dura Mater; whereas in Land-Animals it is a Bundle of Fibres. Vide Philof. Trans. No. 27.

(gg) Certissimum est, quod in omnibus Oculis humanis (quos salten mihi dissecare contigit) Nervus opticus Pupilla è diametro opponitur, &. Brigg's Opthal. cap. 3. fect. 15. Ita Willis de Anim. de Brut. p. I. c. 15.

Nervi Optici in nobis, item in Cane, Fele (& in cateris forfan animalibus calidis) ad fundum Oculi delati Papelle regioni prospicium, dum interim in aliis Quadrupedibus, uti etiam in Piscibus & Volucibus, oblique semper Tunica Sclerotidi inseruntur. Unde, Willis lb. (bb) This cap. 7. fect. 11.

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God's Works. Ishall therefore take Notice only of one Wise Provision the Creator hath made about the Motion of the Eye, by uniting into one the Third Pair of Nerves, called the Motory Nerves (bb), each of which sending its Branches into each Muscle of each Eye, would cause a Distortion in the Eyes; but being united into one, near their Insertion into the Brain, do thereby cause both Eyes to have the same Motion; so that when one Eye is moved this Way and that Way, to this and that Object, the other Eye is turned the same Way also.

Thus from this transient and slight View (I may call it) of the Parts of the Eye, it appears what an admirable Artist was the Contriver thereof. And

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Seventh and last Place, let us consider what Provision this Admirable Artist hath made for the Guard and Security of this so well formed Organ (ii). And here

(bh) This Pair is united at its Rise; whence is commonly drawn a Reason why one Eye being mov'd towards an Object, the other is directed also to the same. Gibson's Anat. Book III. Chap. 11. So Bartholine Anat. Libellus 3. cap. 2.

⁽ii) Among all the other Security the Eye hath, we may reckon the Reparation of the Aqueous Humour; by which Means the Eye when wounded, and that in all Appearance very dangerously too, doth often recover its Sight: Of which Lern, Verzascha gives divers Examples Ancient and Modern. One is from Galen, of a Boy so wounded, that the Cornea fell, and became flaccid, but yet recovered his Sight. Other such like Instances also he gives from Realdus Columbus, Rhodius, and Tulpius; and one that he cured himself in these Words; Ego in Nobilissimi viri filiola similem causam observavi: hac dum levibus de causis cum fratre altercaret, iste iracundia percitus cultellum Scriptorium apprehendit, & sororis oculo vulnus instigit, inde humor aqueus effuxit. Vocatus presentem Chirurgum jussi sequens collyrium anodynum exsiccans tepide sepius admovere. Receipe aq. Plantag. Quatuor Unc. Rosar. Sanicul. Euphras. ana Trochisc. alb. Rhas. cum Opio

here we shall find the Guard equivalent to the Use and Excellency of the Part. The whole Organ fortissed and senced with strong, compact Bones, lodged in a strong, well made Socket, and the Eye it self guarded with a nice made Cover (kk). Its Humours, and its inward Tunicks, are indeed tender,

propor-

due Scrup. Tutia pp. un. Scrup. Croci orent. ½ Scrup. M. Hoc Collyrium inflammationem compescuit, vulnus siccavit & sanavit. Hinc post aliquot menses Humor aqueus succrevit. Nam visus, sed dibilior, cum summo parentum gaudio redivit. B. Verzaschæ Observ. Medicæ. Obs. 14.

Another Cure of this Kind, was experimented by Dr. Daniel Major, upon a Goose, Ann. 1670. the Aqueous Humour of both whose Eyes they let out, so that the Eyes sell, and the Goose became quite Blind: But without the Use of any Medicine, in about two Days Time, Nature repaired the watery Humour again, the Eyes returned to their former Turgency, and the Goose was in a Week after produced Seeing before twenty eight or thirty Spectators. Ephem. Germ. T. 1. Add. ad Obs. 117.

From the same Cause, I doubt not, it was that the Eye of a Gentleman's Daughter, and those of a Cock, when wounded, so that the Cornea sunk, were restored by a Lithuanian Chymist, that passed for a Conjurer, by the Use of a Liquor sound in May, in the Vesiculæ of Elm. Of which see Mr. Raj's

Catal. Cantab. in Ulmus from Henr. ab Heers.

(kk) Palpebra, qua sunt tegumenta Oculorum, mollissima tactu, m inderent aciem, aptissima facta, & ad claudendas Pupilias, ne quid incideret, & ad aperiendas; idque providit, ut identidem sieri posse um maxima celeritate. Munitaque sunt Palpebra tanquam vallo pilorum: quibus & apertis Oculis, si quid incideret, repelleretur, & sommo conniventibus, cum Oculis ad cernendum non egerimus, ut qui, tanquam involuti, quiescerent. Latent praterea utiliter, & excelsis undique partibus sepiuntur. Primum enim superiora Superciliis obducta subrem a capite, & fronte dessuentem repellunt. Gena deinde ab inserver parte tutantur subjecta, leviterque eminentes. Cicer. de Nat. Deor. l. 2. c. 57.

Tully, in the Person of a Stoick, having so well accounted for the Use of the Eye-Lids, I shall for a further Manifestation of the Creator's Contrivance and Structure of them, take Notice of two or three Things: 1. They consist of a thin and flexible, but strong Skin, by which Means they the better wipe, clean, and guard the Cornea. 2. Their Edges are forti-

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proportionate to their tender, curious Uses; but he Coats without, are context and callous, firm and strong. And in some Animals, particularly Birds

ed with a foft Cartilage, by which Means they are not only nabled the better to do their Office, but also to close and nut the better. 3. Out of these Cartilages grow a Pallisade fliff Hairs, of great Use to warn the Eye of the Invasion Dangers, to keep off Motes, and to shut out too excessive light, &c. and at the same time to admit of (through their atervals) a furficient Paffage for Objects to approach the Eye. and it is remarkable, That these Hairs grow but to a certain, ommodious Length, and need no Cutting, as many other lairs of the Body do: Also, That their Points stand out of he Way, and in the Upper-lid bend upwards, as they do bwnwards in the Lower-lid, whereby they are well adapted their Use. From which last Observables, we may learn w critical and nice the great Author of Nature hath been, even the least and most trivial Conveniences belonging to nimal Bodies; for which Reason I have added it to Tully's emarks. And more might have been added too, as particuly concerning the curious Structure and Lodgment of the ght Muscle, which opens the Eye-lids; and the Orbicularis. Circular one, that shuts them; the nice Apparatus of lands that keep the Eye moist, and serve for Tears; together th the Reason why Man alone, who is a Social Animal, th exhibit his Social Affections by fuch outward Tokens as ars; the Nerves also, and other Organs acting in this Mini-I might also speak of the Passages for discharging the perfluous Moisture of the Eyes through the Nostrils, and uch more of the like Kind. But it would take up too much oom in these Notes; and therefore it shall suffice to give ly fuch Hints as may create a Suspicion of a noble OEconoyand Contrivance in this (I had almost faid) least consider-le Part of the Eye. But for Particulars I shall refer to the natomists; and for some of these Things, particularly to r. Willis's Cereb. Anat. and de Anim. Brut. and Mr. Cowper's legant Cuts in the 11th Tab. of his Anatomy.

To the Eye-lids we may add another Guard afforded the yes of most Quadrupeds, Birds, and Fishes, by the Nistitag-Membrane, which Dr. Willis gives this Account of, Plurius [Animalibus] quibus Musculus suspensorious adest (which imitation he need not to have added) etiam alter Membraus conceditur, qui juxta interiorems oculi canthum situs, quando ele-

vatte

Birds (11), some Part of those Tunicles have the Nature and Hardness of Bone or Horn.

But for Creatures, whose Eyes, like the rest of their Body, are tender, and without the Guard of Bones; there Nature hath provided for this necessary and tender Sense, a wonderful kind of Guard, by endowing the Creature with a Faculty of withdrawing its Eyes into its Head (mm), and lodging them in the same Safety with the Body.

Thus have I survey'd this first Sense of Animals, I may say, in a cursory, not accurate, strict Manner,

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BOOK IV.

vatur, Oculi globum fere totum obtegit. Hujus usus esse videtur, utum Bestia inter gramina, &c. capita sua propter victum capessedum demergunt, hic Musculus Oculi Pupillam, ne à stipularum incursuseitatur, oculit, munitque. De Anim. Brut. p. 1. c. 15.

This Membrane Man hath not, he having little Occasion to thrust his Head into such Places of Annoyance, as Beasts, and other Animals; or if he hath, he can defend his Eyes with his Hands. But Birds (who frequent Trees and Busses) and Quadrupeds, (Hedges and long Grass) and who have no Part ready, like the Hand, to fence off Annoyances; these, I say, have this incomparable Provision made for the Safety of their Eyes. And for Fishes, as they are destitute of Eye-Lids, because in the Waters there is no Occasion for a Desensative against Dust and Motes, offensive to the Eyes of Land-Animals, not to moisten and wipe the Eyes, as the Eye-Lids do, so the Nistitating-Membrane is an abundant Provision for all their Occasions, without the Addition of the Eye-Lids.

And now, if we reflect, are these the Works of any Thing

but a Wife and Indulgent Agent?

(11) Although the Hardness and Firmness of the Admats, or Sclerotica in Birds, is a good Guard to their Eyes, yet I do not think it is made thus, so much for a Defence, as to minister to the lengthning and shortning the Eye, mentioned before in Note (cc).

(mm) Cochleis oculorum vicem Cornicula bina pratentu implent. Plin. Nat. Hist. 1. 11. c. 37. See more of the Eyes of Small before in Note (k); and in Note (l), I said that I suspected Moles also might thrust out, or withdraw their Eyes more or less within the Hair or Skin.

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onfidering the prodigious Workmanship thereof ut fo, as abundantly to demonstrate it to be the Contrivance, the Work of no less a Being than the Infinite Wife, Potent, and Indulgent Creator (nn). or none less could compose so admirable an Oran, so adapt all its Parts, so adjust it to all Occaons, so nicely provide for every Use, and for every mergency: In a Word, none less than God could, fay, thus contrive, order, and provide an Organ, s magnificent and curious as the Sense is useful; a ense without which, as all the Animal World would e in perpetual Darkness, so it would labour under erpetual Inconveniencies, be exposed to perpetual farms, and fuffer perpetual Wants and Distresses. ut now by this admirable Sense, the great God, ho hath placed us in this World, hath as well proded for our comfortable Residence in it; enabled to see and chuse wholsome, yea, delicate Food; provide our felves ufeful, yea, gaudy Cloathing, nd commodious Places of Habitation and Retreat. Ve can now dispatch our Affairs with Alacrity and leafure, go here and there as our Occasions call us. Ve can, if need be, ranfack the whole Globe, peetrate into the Bowels of the Earth, descend to e Bottom of the Deep, travel to the farthest Reions of this World, to acquire Wealth, to encrease ur Knowledge, or even only to please our Eye and Fancy.

⁽nn) The diligent Sturmius was fully perswaded there could ot be any speculative Atheism in any one that should well urvey the Eye. Nobis, saith he, suit persuasissimum, Atheisum, quem vocant speculativum, h. e. obsirmatam de Deltate in Unition nulla persuasionem, habere locum aut inveniri non posse in eo homino, ii vel unius corporis organici, & speciatim Oculi sabricam attento nimo aspexerit. Sturm. Exerc. Acad. 9. De Vis. Organ. & at, in Epilogo.

Book IV.

Fancy. We can now look about us, discern and shun the Precipices and Dangers which every where enclose us, and would destroy us. And those glorious Objects which fill the Heavens and the Earth, those admirable Works of God which every where surround us, and which would be as nothing to us, without being seen, do by Means of this noble Sense present their Glories to us (00), and fill us with Admiration and Pleasure. But I need not expatiate in

(00) The glorious Landskips, and other Objects that prefent themselves to the Eye, are manifestly painted on the R. tina, and that not erect, but inverted as the Laws of Opticks require; and is manifest to the Eye from Monsieur Carteis Experiment, of laying bare the vitreous Humour on the Back. part of the Eye, and clapping over it a Bit of white Paper, or the Skin of an Egg; and then placing the Fore-part of the Eye to the Hole of the Window of a darkned Room, By which Means we have a pretty Landskip of the Objects abroad invertedly painted on the Paper, on the Back of the Eye. But now the Question is, How in this Case the Eye comes to see the Objects erect? Monfieur Cartes's Answer is, Notitia illiant nulla imagine pendet, nec ex ulla actione ab objectis veniente, sed ex sil situ exiguarum partium cerebri, è quibus Nervi expullulant. - E.g. cogitandum in Oculo-fitum capillamenti nervi optici-responden ad alium quendam partis cerebri-qui facit ut Anima singula lut cognoscat, que jacent in recta, aut quasi recta linea; ut ita mirari mi debeamus corpora in naturali situ videri, quamvis imago in oculo dellineata contrarium habeat. Dioptr. c. 6. But our most ingenious Mr. Molyneux answereth thus; The Eye is only the Organ or lastrument, it is the Soul that sees by Means of the Eye. To enquire then how the Soul perceives the Object erect, by an inverted Image, is enquire into the Soul's Faculties ___ But erect and inverted are on Terms of Relation to up and down; or farther from, or nigher to the Centre of the Earth, in Parts of the Same Thing .____ But the Eye, " visive Faculty takes no Notice of the internal Posture of its own Parts but useth them as an Instrument only, contrived by Nature for the Emcife of such a Faculty. - Let us imagine, that the Eye (on its lower Part) receive an Impulse [by a Ray from the upper Part of the Object] must not the visive Faculty be necessarily directed hereby consider this Stroke, as coming from the Top rather than the Bottom [d the Object I and consequently be directed to conclude it the Representathe record

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the Usefulness and Praises of this Sense, which we receive the Benefit of every Moment, and the Want or any Defect of which, we lament among our

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Leaving then this Sense, I shall proceed to the other four, but more briefly treat of them, by Reafon we have so ample a Sample of the Divine Art in the last, and may presume that the same is exerted in all as well as one. For a Demonstration of which, let us in the next Place carry our Scrutiny to the Sense of Hearing.

tion of the Top? Hereof we may be satisfied, by supposing a Man standing on his Head. For here, though the upper Parts of Objects are painted on the upper Parts of the Eye, yet the Objects are judged to be Erect: What is said of Erett and Reverse, may be understood of Sinister and Dexter. Molyneux's Dioptr. Nov. Part I. Prop. 28.

CHAP. III. Of the Sense of Hearing.

Oncerning the Sense of Hearing, I shall take Notice of two Things, the Organ, the Ear;

and its Object, Sound.

I. For the Organ, the Ear; I shall pass by its convenient Number of being double, which (as in the last Sense) serves for the commodious Hearing every Way round us; as also a wife Provision for the utter Loss or Injury (a) of one of the Ears. But I shall a little infift upon its Situation, and its admirable Fabrick and Parts.

⁽a) I prefume it will not be ungrateful to take Notice here of the admirable, as well as useful Sagacity of some deaf Persons, that have learn'd to supply their want of Hearing by understanding what is said by the Motion of the Lips. My very ingenious Friend Mr. Waller, R. S. Secr. gives this Account: There live now, and have from their Birth, in our Town, a

the Body, (like as I said the Eye is) in a Part near the common Sensory in the Brain, to give the more speedy Information; in a Part where it can be best guarded, and where it is most free from Annoyances and Harms it self, and where it gives the least Annoyance and Hindrance to the Exercises of any other Part; in a Part appropriated to the peculiar Use of the principal Senses, in the most losty, eminent Part of the Body, where it can perceive the most Objects, and receive the greatest Information: And lastly, in a Part in the Neighbourhood of its

Man and his Sister, each about fifty Years old, neither of which have the least Sense of Hearing,—yet both of these knew, by the Motion of the Lips only, whatever is said to them, and will answer pertinently to the Question proposed to them—The Mother told me they could hear very well, and speak when they were Children, but both lost that Sense afterwards, which makes them retain their Speech; though that to Persons not used to them, is a little uncouth and odd, but intelligible enough. Philosoph. Trans. No. 312.

Such another Instance is that of Mr. Goddy, Minister of St. Gervais in Geneva, his Daughter. She is now about fixteen Years old. Her Nurse had an extraordinary Thickness of Hearing; at a Year old, the Child spake all those little Words that Children begin to speak at that Age. - At two Years old, they perceived she had lost her Hearing, and was so Deaf, that ever since, though she hears great Noises, yet she hears nothing that one can speak to her. But by obferving the Motions of the Mouth and Lips of others, she hath acquired so many Words, that out of these she hath formed a Sort of Fargon, in which she can hold Conversation whole Days with the se that can speak her own Language. I could understand some of her Words, but could not comprehend a Period, for it seemed to be but a confused Noise. She knows nothing that is said to her, unless he seeth the Motion of their Mouths that speak to her; so that in the Night, when it is necessary to speak to her, they must light a Candle. Only one thing appeared the strangest Part of the whole Narration: She hath a Sister, with whom she bath practised her Language more than with any other: And in the Night, by laying her Hand on her Sifter's Mouth, he can perceive by that what he faith, and so can discourse with her in the Night. Bishop Burnet's Let. 4. p. 248. (b) I Siff addition of we cou

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Sister Sense the Eye, with whom it hath peculiar and admirable Communication by its Nerves, as I intend to shew in its proper Place. In respect then of its Situation and Place in the Body, this Sense is well designed and contrived, and may so far be accounted the Work of some admirable Artist. But,

2. If we survey its Fabrick and Parts, it will appear to be an admirable Piece of the Divine Wisdom, Art, and Power. For the Manifestation of which, let us distinctly survey the outward and the

inward Part of its curious Organ.

1. For the outward Ear: If we observe its Structure in all kinds of Animals, it must needs be acknowledged to be admirably Artificial, it being so nicely prepared, and adjusted to the peculiar Occasions of each respective Animal. In Man (b), it is

⁽b) I cannot but admire that our most eminent modern Anatomists should not agree, whether there be any Muscles in the outward Ear of Man or not. Dr. Keil faith there are two; Dr. Drake the same Number; and Dr. Gibson makes them to be four. So also doth Monsieur Dionis, and so did the ancient Anatomists: But Dr. Schelhammer expressly denies there are any, and faith, Seduxit autem reliquos Brutorum Anatome in quorum plerisque tales Musculi plures inveniuntur; putarunt autem fortassis ignominiosum Homini, si non & bis instructus esset, & minus inde perfectum animal fore. Schel. de Auditu, p. 1. c. 1. Sect. 7 But Valsalva, who wrote very lately, and is very accurate in his Survey of the Ear, faith, Musculi auricula posteriores quandoque quatuor, quandoque duo ; sed ut plurimum tres adnotantur; Eguando solum duo se manifestant, tunc unus ex illis duplicato tendine versus Concham deferri solet. Horum musculorum in numero varietatem non solum in diversis; verum etiam in eodem subject quandoque vidi-Ex quibus differentiis Suborta sunt Aufforum discrepantia in borum Musculorum numero. & positu:-quod non evenisset, si pluries in diversis Corporibus iidem Musculi quasiti essent. Ant. Mar. Valsalva de Aur. Human. c. 1. Sect. 6. But Dr. Drake thinks some of Valsalva's Muscles the Product of Fancy. Mr. Cowper makes them to be three, one Attollent, and two Retrahent Muscles. See Anat, Tab. 12.

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of a Form proper for the erect Posture of his Body. In Birds, of a Form proper for Flight; not protuberant, because that would obstruct their Progress, but close and covered, to afford the easier Passage through the Air. In Quadrupeds, its Form is agreeable to the Posture, and slower Motion of their Bodies; and in these too, various, according to their various Occa riss. In some large, erect, and open, to hear the Approaches of Dangers (c), in others covered, to eep our noxious Bodies. In the Subterraneous Quadrupeds, who are forced to mine and dig for their Food and Habitation, as a protuberant Ear, like that of other Quadrupeds, would obstruct their Labours, and be apt to be torn and injured; fothey have the contrary (d), their Ears short, lodged

(c) Inter catera [animalia aurita] maxime admirabilis est auris leporina fabrica, quod cum timidissimum animal sit, & prorsus inerme, natura id tum auditu acutissimo, tanquam hostium exploratore ad persentienda pericula, tum pedibus ceu armis ad currendum aptis munisse videtur. A. Kircher's Phonurg. l. 1. Sect. 7. Technas. 2.

(d) Moles have no protuberant Ear, but only a round Hole between the Neck and Shoulder; which Situation of it, together with the thick, short Fur that covers it, is a sufficient Desensative against external Annoyances. The Neatus Auditorius is long, round and cartilaginous, reaching to the under part of the Skull. Round the inside runs a little Ridge, resembling two Threads of a Skrew; at the Bottom whereof is a pretty Inlet leading to the Drum, made, on one side with the aforesaid cochleous Ridge, and on the other, with a small Cartilage. I observed there was Cerumen in the Meatus.

As to the inner Ear, it is somewhat singular, and different from that of the other Quadrupeds, and much more from Birds, although I have met with some Authors that make it agreeing with that of Birds. There are three small Bones only (all hollow) by which the Drum (to use the old Appellation) or the Membrana Tympani (as others call it) acteth upon the Auditory Nerve. The sirst is the Malleus, which hath two Processes nearly of equal Length; the longer of which is braced to the Membrana Tympani, the shorter to the side

lodged deep and backward in their Head, and paffing to the under Part thereof, and all sufficiently fenced and guarded. And as for Insects, Reptile, and the Inhabitants of the Waters, if they enjoy this Sense, (as there is great Reason to think they do), it may probably be lodged commodiously un-

der

fide of the Drum or Os Petrofum; the back part of it resembles the Head and Stalk of a small Musbroom, sich as are pickled. On the back of the Malleus lies the next small Bone, which may be called the Incus, long, and without any Process, having somewhat the Form of the short Scoop wherewith Water-men throw the Water out of their Wherries. To the end of this the third and last small Bone is tacked by a very flender Brace. This little Bone bears the Office of the Stapes, but is only forked without any Base. One of these Forks is at one Fenestra, or Foramen, the other at another; in which Fenefire I apprehend the Forks are tacked to the Auditory Nerve. These Fenefira (equivalent to the Fenefira Ovalis, and Rotunda in others) are the Inlets into the Cochlea and Canales Semicirculares, in which the Auditory Nerve lieth. The Semicircular Canales lie at a distance from the Drum, and are not lodged (as in other Animals) in a strong, thick Body of Bone, but are thrust out, within the Skull, making an Antrum, with an handsome Arch leading into it, into which a part of the Brain enters.

One Leg of the Malleus being fastned on the Membrana Tympani, and the Incus to the back of the Malleus, and the top of that to the top of the Stapes, and the Forks or Branches of the Stapes to the Auditory Nerve, I observed that whenever I moved the Membrane, all the little Bones were at the same time moved, and consequently the Auditory Nerve there-

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I hope the Reader will excuse me for being so particular in this Organ only of the Mole, a despised Creature, but as notable an Example of God's Work, as its Life is different from that of other Quadrupeds; for which Reason it partly is that I have enlarged on this part differing from that of others, and which no Body that I know of, hath taken much notice of, and which is not discoverable without great Patience and Application; and partly because by comparing these Observations with Book VII. Chap. 2. Note (d), we may judge how the Sense of Hearing is performed.

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der the same Security and Guard, as the Smelling, or some other Sense is.

And moreover, as the Form of this Organ is various in various Animals, fo in each of them its Structure is very curious and observable, being in all admirably contrived to collect the wandering, circumambient Impressions, and Undulations of Sound, and to convey them to the Senfory within, If I should run over the several Genera of Animals, we might find a notable Prospect of the Handy-work of God (e), even in this fo inconfiderable a Part of But I shall only carry my Survey to Animals. that of Man. And here the first Thing that offereth it felf to our View, is the Helix, with its tortuous Cavities, made to stop, and collect the sonorous Undulations, to give them a gentle Circulation and Refraction, and so convey them to the Concha, or larger and more capacious round Cell at the Entrance of the Ear. And to bridle the Evagation of the Sound, when arrived so far, but withal not to make a Confusion thereof, by any disagreeable Repercuffions, we may take Notice of a very curious Provision in those little Protuberances, called the Tragus,

⁽e) Among many Varieties, both in the inner and outer Ear, those which appear in the Passage into the Rock-Bone, are remarkable. For in an Owl, that perches on a Tree or Beam, and hearkens after the Prey beneath her, it is produced farther out above than it is below, for the better Reception of the least Sound. But in a Fox, that scoutch underneath the Prey at Rooss, it is for the same Reason produced farther out below. In a Pole-Cat, which hearkens strait forward, it is produced behind, for the taking of a forward Sound. Whereas in a Hare, which is very quick of Hearing, and thinks of nothing but being pursued, it is supplied with a bony Tube, which, as a natural Otocoustick, is so directed backward, as to receive the smallest and most distant Sound that some behind her. Grew's Cosmolog, Sacr, lib. 1. c. 5. Sect. 6.

(i) It

Tragus, and Antitragus of the outward Ear, of a commodious Form and Texture (f), and conveniently lodged for this Use. The great Convenience and Benefit of this Form and Contrivance of the outward Ear, is sufficiently manifest by the want thereof, which causeth a Confusion in the Hearing, with a certain Murmur, or Swooing like the

Fall of Waters (g).

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(b) Gilf. Ibid.

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Another wife Provision of the Creator, is in the Substance of the outward Ear, which is cartilaginous, the fittest for this Place. For (as an ingenious Anatomist (b) observes, " If it had been Bone, "it would have been troublesome, and might by " many Accidents have been broken off: If Flesh, " it would have been subject to Contusion". But indeed a worfe Confequence than this would have enfu'd fuch a Softness as that of Flesh, and that is, it would neither have remain'd expanded, neither would it fo kindly receive and circulate the Sounds, but absorb, retard, or blunt their Progress into the inward Organ. But being hard, and curioufly smooth and tortuous, Sounds find an easy Passage, with a regular Volutation and Refraction: As in a well-built Arch, Grotto, or mufical Instrument, which magnify and meliorate Sounds; and some

⁽f) The Texture of the Iragus and Antitragus, is softer than that of the Helix, which ferweth gently to blunt, not forcibly to repel the Sound in the Concha.

⁽e) Dr. Gibson's Anatomy, Chap. 22. Book III. Those whose Ears are cut off, have but a confused way of Hearing, and are obliged either to form a Cavity round the Ear with their own Hands, or else to make use of a Horn, and apply the end of it to the inner Cavity of the Ear, in order to receive the agitated Air. 'Tis likewife observed, that those whose Ears jut out, hear better than flat-eared Persons. Monsieur Dionis's Anat, Demonstr. 8.

of which convey even a Whisper to a large Dif. tance (i): But from the outward, let us carry

our Survey.

2. To this inward Part of this admirable Organ. And here we find the most curious and artful Provision for every Emergency and Occasion. The auditory Passage, in the first Place, curiously tunnelled, and artfully turned, to give Sounds an easy Patlage, as well as a gentle Circulation and Refraction; but withal, so as to prevent their too furious rushing in, and affaulting the more tender Parts within.

And forasmuch as it is necessary that this Passage

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BOOK IV.

(i) It would nauseate the Reader to reckon up the Place famed for the Conveyance of Whifpers, fuch as the Prison of Dionysius at Syracuse, which is said to increase a Whisper to a Noise; the clapping ones Hands to the Sound of a Cannon, &c. Nor the Aquaducts of Claudius, which carry a Voice fixteen Miles, and many others both Ancient and Modera, If the Reader hath a mind to be entertained in this way, he may find enough in Kircher's Phonurgia. But it may not be irksome to mention one or two of our own in England, Among which, one of the most farned is the Whispering-Plat in Gloucester Cathedral, which is no other than a Gallery above the East-end of the Choir, leading from one fide thercofto the other. It confifteth (if I mistake not) of five Angles, and fix Sides, the middlemost of which is a naked, unco vered Window, looking into a Chapel behind it. the two Whisperers stand at about twenty five Yards Diftance from one another. But the Dome of St. Paul's, Lundon, is a more confiderable Whispering-Place, where the ticking of a Watch (when no Noise is in the Streets) may be heard from Side to Side; yea, a Whisper may be sent all round the Dome. And not only in the Gallery below, but above, upon the Scalfold, Itried, and found that a Whifper would be carried over one's Head round the Top of the Arch, notwithstanding there is a large Opening in the Middle of it, into the upper Part of the Dome.

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should be always open, to be upon the Watch (k); therefore to prevent the Invasion of noxious Infects, or other Animals, (who are apt to make their Retreat in every little Hole,) Nature hath secured this Passage (l), with a bitter nauseous Excrement (m), afforded from the Glands (n) appointed for that Purpose. From

(k) Auditus autem semper patet: ejus enim sensu etiam dormientes egemus: A quo cum sonus est acceptus, etiam è sonno excitamur. Flexuosum iter habet, ne quid intrare possit, si simplex, & direttum pateret; provisum etiam, ut siqua minima bestiola conaretur irrumpere, in sordibus aurium, tanquam in visco, inharesceret. Cicer. de Nat. Deor. 1. 2. C. 57.

It deferves a particular Remark here, that in Infants in the Womb, and newly Born, the Meatus Auditorius is shut up very closely, partly by the Constriction of the Passage, and partly by a glutinous Substance, whereby the Tympanum is guarded against the Water in the Secundine, and against the

Injuries of the Air as foon as the Infant is born.

(1) It is remarkable, that in most, if not all Animals, whose Ears are tunnelled, or where the Meatus Auditorius is long enough to afford Harbour to Ear-wigs, or other Insects; that, I say, in the Ears of such, Ear-wax is constantly to be found. But in Birds, whose Ears are covered with Feathers, and where the Tympanum lies but a little Way within the Skull, no Ear-wax is found, because none is necessary to the Ears so

well guarded, and fo little tunnelled.

(m) The Ear-wax was thought, by the old Anatomists, to be an Excrement of the Brain: Humor biliosus à cerebro expugnatus, the Bartholines say of it, l. 3. c. 9. But as Schelhammer well observes, Nil absurdius, quam cerebri excrementum boc statuere. Nam & ratio nulla suadet, ut in cerebro sieri excrementum tale credamus:——neque via patent per quas ab eo seclusum in meatum audicrium possit inde penetrare. As to its Taste, Casserius gives Inflances of its being Sweet in some Creatures. But Schelhammer says, Ego verò semper, cum amaritie aliquid dulcedinis in illo depresendi. Vide Schel. de Audit, p. 1. c. 2. sest. 10. But I could never distinguish any Sweetness in it; but think it insipid mixed with a Bitterness.

(n) Cerumina amara Arteriolis exudantia, Willisde Anim. Brut.

ar. 1. c. 14. In the Skin—are little Glands, which furnish a yellow and hitter Humour, Monsieur Dionis's Dem. 18. An handsome Cut of those Glandula Ceruminosa is in Dr. Drake, from Valsalva.

Pliny

BOOK IV.

The t that fine Membro

a fubstan pole the may be t that it m the audi

Gentlema reaching t an Ulcer a stopt with in the left

> out. Ibid. (9) Os parietes conj ld autem à Sonorum ob Parietibus, illum qualer mali content Raym. Vieu

(r) Th derns, the Hippocrates' ward Pari Parts. N. whole Circu the upper for vent to the fome Paff Dionis ever felf carefi ber to have the dilige

through t

From hence let us approach the most inward Parts, in which we shall see Strokes of the most exquisite Art. To pass over the innate Air, that most Authors talk of (0), (because there is no such) the Passage to the Palate (p), and their Uses, with divers other curious Things that might be named;

Pliny attributes a great Virtue to the Ear-wax; Morfus he. minis inter asperrimos numeratur: medentur sordes ex auribus: àc ne quis miretur, etiam Scorpionum icibus Serpentiumque statim imposits. Plin. Nat. Hift. 1. 28. c. 4. And that it hath an healing Quality, and may be accounted a good Balfam, I my felf have experienced.

(e) That there is fuch a Thing as the innate Air, (talked of much by most Authors on this Subject) Schelhammer very justly, I think, denies; by Reason there is a Passage into the inner Ear from the Throat, through which the innate Air may pass out, and the outward Air enter in. Vide Par. Alf. p. 2. c. 1. feet. 10. When by stopping our Breath, and straining, we force the external Air into the Ear, it may be heard rushing in; and if much be forced in, it may be felt also to beat against the Tympanum. When the Passage to the Throat is by any Means stopped, as by a Cold in the Head, &c. the Hearing thereby becomes dull and blunt; by Reason the Communication between the outward and inward Air are obstructed: But when by strong Swallowing, or such like Motion of the Throat, the Passage is opened, we perceive it by a fudden Smack or Crack, and we immediately hear very clearly; the load of feculent Air being at that Time difcharged from the inner Ear.

It is a wife Provision, that the Passage for the Air into the Ear, is from the Throat; Ut non statim quivis aer externus irrumpere queat (as Schelhammer faith, Par. ult. c. 4. Sett. 8.) fed nonnibil immutatus, ac temperatus, calore ex medio ventre exfpirante;

imo fortassis non facile alius, nist expulmonibus.

(p) Valsalva hath given us a more accurate Description of the Tuba Eustachiana, or Passage to the Palate, than any other Author, to whom I therefore refer, De Aur. Human. c. 2. Sect. 16. Oc.

The chief Use hereof, he thinks, is to give way to the inner Air, upon every Motion of the Membrana Tympani, the Malleus, Incus and Stapes. This Paffage, if it be shut up, Deafnels enfues: Of which he gives two Instances: One a Gentleman, let us stop a little at the Part containing the rest, namely, the Bone (q). The particular Texture and Hardness of which, above other Bones of the Body, is very remarkable; whereby it serves not only as a substantial Guard to the Sensory, but also to oppose the Impulses of the ætherial Matter, that there may be no Loss nor Consusion in the Sound; but that it may be convey'd regularly, and intirely to the auditory Nerves.

The next Part I shall take Notice of, may be that fine Membrane, called the Tympanum, or Membrana Tympani (r), with its inner Mem-

brane

Gentleman, who lost his Hearing by a Polypus in the Nose reaching to the Uvula; the other a Yeoman, labouring with an Ulcer above the left Side of the Uvula; which when he stopt with a Tent dipped in Medicine, he lost his Hearing in the left Ear, and recovered it, as soon as the Tent was out. Ibid. c. 5. Sect. 10.

(q) Os [petrosum] ex quo interiores [Labyrinthi] cavitatum parietes conflati sunt, album, durissimum, necnon maxime compactum. Id autem à Naturâ ita comparatum esse videtur, ut materia etherea Sonorum objectorum impressionibus onusta, dum pradictis impingitur Parietibus, nihil aut saltem ferè nihil motûs sui amittat, atque adei illum qualem ab Objectis sonoris accepit, talem communicet spiritui animali contento intra expansiones rami mollioris Nervorum auris. Dr.

Raym. Vieussens of Montpellier, in Phil. Trans. No. 258.

(r) The Tympanum of the Ear, or as Valsalva and the Moderns, the Membrana Tympani was taken notice of as early as Hippocrates's Time. In Birds, it is strained towards the outward Parts; in other Animals towards the Brain, or inner Parts. Monsieur Dionis saith, It is not equally fastened to the whole Circumference of the bony Circle, in which it is inchased; for on the upper side it bath a free disengaged Part, by which some can give vent to the Smoak in their Mouth. Demonstr. 8. That there is some Passage I doubt not, but I question whether Monsieur Dionis ever saw the disengaged Part he mentions. I have my self carefully searched divers Subjects, and do not remember to have seen any such Passage; and I perceive it escaped the diligent Schelk ammer's Eye. Valsalva also by injecting in through the Tuba Eustachiana, cou'd not force any Liquor

brane (s); together with the four little appendent Bones (t), and the three inner Muscles to move them, and adjust the whole Compages to the several

Pur-

Passage out in another Place of the Drum, in some morbid, and one sound Head. Valsalv. de Aur. Hum. c. 2. Sect. 8. Mr. Cowper also affirms there is a Passage by the upper Part of

the Membrane. Anat. Ap. Fig. 8.

(s) Dr. Vieusens, before-named, discovered a Membrane, tenuissima raraque admodum textura intra cavitatem Tympani; as he describes it. Whose use he saith is, t. Occludens Labyrinthi januam impedit ne naturalis purissimus ac subtilissimus Aer intra cavitates—communicationem—habeat cum aere crasse. 2. Labyrinthi basin calefacit, &c. ubi supra. Probably this double Membrane may be such, or after the same manner as it is in the Tympanum of Birds: Of which see my Observations in Book VII.

Chap. 2. Note (d).

(t) The four little Bones being treated of by all that have concerned themselves about this Sense of Hearing, fince their Discovery, I shall take Notice of only two Things concerning them. 1. The Discovery of them is owing wholly to the Diligence and Sagacity of the latter Ages; of which Schelhammer gives this Account from Fallopius: Hec Officula antiquis Anatomicis-ignota fuere; primusque qui in lucem produxit [Malleum & Incum] fuit Fac. Carpensis; primus quoque proced omni dubio Anatomica artis, quam Vesalius postea perfecit, restaurato. Tertium [Stapedem] invenit ac promulgavit primus Joh. Phil. ab Ingrassia, Siculus, Philosophus, ac Medicus doctissimus. Thoma Bartholin, teste, viro longe celeberrimo, Fran. Sylvio debetut Schel. ubi supra, c. 3. Sect. 9. 2. Their Difference in Animals: In Man, and Quadrupeds, they are four, curioully inarticulated with one another; with an external and internal Muscle to draw, or work them, in extending, or relaxing the Drum; but in Fowls the Case is very different : His unum Ossiculum solum largita est Natura, quod Collumellam forte appellaveris : teres enim est & subtilissimum, basi innitens latiori, rotunda. Huic adnexa est cartilago valde mobilis, que in Tympanum videtur terminari. Id. Ib. Sect. 8. In the Ears of all the Fowl that I could examine, I never found any more than one Bone, and a Cartilage, making a Joynt with it, that was easily moveable. The Cartilage had genrally an Epiphyse, or two, one on each Side. The Bone was very kard and small, baving at the end of it a broad Plate, of the same Substance, very thin, upon which it rested, as on its Basis. Dr. Al. Moulen in Phil. Tranf. No. 100.

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Purposes of Hearing, to hear all manner of Sounds, loud or languid, harsh or grateful (u). From

These are the most material Things I find observed by others, concerning the Ears of Fowls, and some of them hardly, I believe, observed before. To which I shall subjoyn some other Things I have my self discovered, that I presume escaped the Eyes of those most curious and inquisitive Anatomists. Of which the last cited Book VII. Chap. 2. Note (d).

(u) Videtur quod Tympanum Auditionis instrumentum praliminare & quasi praparatorium fuerit, quod Soni impressionem, sive species sensibiles primo suspiciens, eas in debita proportione, & apta conformitate, versus Senforium, quod adhuc interius situm est, dirigat : simili officio fungitur respectu Auditus, ac tunica Oculi Pupillam constituentes, respectu Visus ; utraque Membrana Species sensibiles refringunt & quase emolliunt, easque Sensorio non nist proportionatas tradunt, cui nudo si adveniant, teneriorem ejus crasin facile ladant, aut obruant. Revera Tympanum non audit, sed meliori tutiorique Auditioni confert. Si hac pars destruatur, Sensio adhuc aliquamdiu, redi licet modo, peragi possit; quippe experimento olim in Cane fatto, &c. - Janitoris officio ut Tympanum recte defungi possit, expansum ejus pro data occasione stringi aut relaxari debet, veluti nimirum Oculi Pupilla-Quapropter buic Auris Tympano, non secus ac bellico, machine sive tenia quadam apponuntur, qua superficiem ejus modò tensiorem, modò laxiorem reddant: hoc enim essiciunt tria Ossicula, cum Musculo, &c, Willis de Anim. Brut. c. 14.

For this Opinion of Dr. Willis, Dr. Schelhammer is very fevere upon him, deriding the Refractions he speaks of; and therefore feriously proves that they are the Humours, not Tunicks of the Eye, that refract the Rays of Light; and then jeeringly demandeth, Whether the fonorous Rays are refracted by passing through a different Medium? Whether the Convexity or Concavity of the Drum collects those Rays into a focal Point, or scatters them? &c. And then faith, Ob has rationes à clariss. Viri, ac de re Medica praclare meriti, sententià non possumus non esse alieniores; in quo uti ingenium admiror, quoties medicamentorum vires, aut morborum causas explicat, sic ubi forum suum egressus Philosophum agit, ac vel Partium usum, vel Chymicarum rerum naturam scrutetur, ejus baud semel non modo judicium desidero, verum aliquando etiam sidem. This is so severe and unjust a Censure of our truly famous Countryman, (a Man of known Probity) that might deserve a better Answer; but I have only Time to fay, that although Dr. Schelhammer hath out-done all that wrote before him, in his Book de Auditu, and shewed himself a Man of Learning and Industry; yet

From this Region of the Tympanum, I might pass

as our Countryman wrote more than he, (though perhaps not free from Errors too) fo he hath manifested himself to have been as curious and fagacious an Anatomist, as great a Philosopher, and as learned and skilful a Physician, as any of his Censurers, and his Reputation for Veracity and Integrity, was no less than any of theirs too. But after all this terrible Clamour, Dr. Schelhammer prejudicately mistaketh Dr. Willis's Meaning, to fay no worse. For by utraque Mem. brana refringunt, Dr. Willis plainly enough, I think, means no more than a Restriction of the Ingress of too many Rays; as his following explicatory Words manifest, viz. refringunt, & quast emolliunt, easque Sensorio non nist proportionatas tradunt. But indeed Dr. Schelhammer hath shewn himself a too rigid Cenfor, by making Dr. Willis fay, the Eur-Drum hath fuch like Braces as the War-Drum, viz. Quod porrò de machinis seu taniis Tympani bellici adducit, dicitque idem in Tympano auditorio conspici, id prersus falsissimum eft. I wonder Dr. Schelhammer did not also charge Dr. Willis with making it a Porter, fince he faith in the same Paragraph, Janitoris officio, &c. But Dr. Willis's Meaning is plain enough, that the little Bones and Muscles of the Ear-Drum do the same Office in straining and relaxing it, as the Braces of the War-Drum do in that. And confidering how curious and folemn an Apparatus there is of Bones, Muscles, and Joynts, all adapted to a ready Motion; I am clearly of Dr. Willis's Opinion, that one great Use of the Ear-Drum is for the proportioning Sounds, and that by its Extension and Retraction, it corresponds to all Sounds, loud or languid, as the Pupil of the Eye doth to feveral Degrees of Light: And that they are no other than fecondary Uses affigned by Dr. Schelhammer, as the principal or fole Uses of keeping out the external colder Air, Duft, and other Annoyances; but especially that, Ob solius aeris interni potissimum irrumpentis vim, bunc motum Tympani ac Mallei effe conditum, ut cedere primum, deinde sihi restitui queat; as his Words are, P. ult. c. 6. fect. 13.

It was no improbable Thought of Rohault, Nos attentos prabere, nil aliud est, nisi Tympanum, ubi ita opus est facto, contendent ant laxare, & operam dare ut illud in ea positione intentum stet, in qua tremulum aeris externi motum commodissime excipere possit. Roh. Phys. p. 1. c. 26. sect. 48.

The Hearing of deaf Persons more easily by Means of loud Noises, is another Argument of the Use of the Straining of Relaxation of the Tympanum in Hearing. Thus Dr. Walls

CHA:

ubi fuj icet Surd verba qui ervo domi ud haber Sampanil us facile Abscrift exatur ['] Upon ns, abou erform he Ear, Pa. I wa y my fe And afre nay give eeing, Note (d) o Men a nore cor uditory Membran Man, it vith the djusted Membrana auditory I Membrane neus upo he audito the Operc within w auditory N the true mov'd, y and work

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pass to that of the Labyrinth (w), and therein survey

(ubi fupra) Accept olim à viro fide digno, se mulierem novisse, qua icet surda suerit, quousque tamen intra conclave Tympanum pulsaretur, verba quevis clare audiebat: quare Maritus ejus Tympanistam pro èrvo domestico conducebat, ut illius ope, collòquia interdum cum Uxore ud haberet. Etiam de alio Surdastro mibi narratum est, qui prope campanile degens, quoties una plures Campana resonarent, vocem quam-

is facile andire. & non alias, potuit,

Abscisso Musculo [Processus majoris Mallei] in recenti aure, reexatur [Tympani Membrana.] Valfalo. de Aur. Hum. c. 2. fect. 5. Upon confidering the great Difference in Authors Opions, about the Use of the Parts; and Manner how Hearing is performed, as also what a curious Provision there is made in he Ear, by the four little Bones, the Muscles, Membrane, y my felf into this Part, and not to rely upon Authority. and after a diligent Search of various Subjects, I find we nay give as rational and easy an Account of Hearing, as of beeing, or any other Sense; as I have shewn in my last cited Note (d), Book VII. Chap. 2. with relation to Birds. And as o Men and Beasts, the Case is the same, but the Apparatus nore complex and magnificent. For whereas in Birds, the uditory Nerve is affected by the Impressions made on the Membrane, by only the Intermediacy of the Collumella; in Man, it is done by the Intervention of the four little Bones, vith the Muscles acting upon them; his Hearing being to be djusted to all kinds of Sounds, or Impressions made upon the Membrana Tympani. Which Impressions are imparted to the suditory Nerve, in this Manner, viz. First they act upon the Membrane and Malleus, the Malleus upon the Incus, and the neus upon the Os Orbiculare and Stapes; and the Stapes upon he auditory Nerve: For the Base of the Stapes (the same as the Operculum in Birds) not only covers the Fenestra Ovalis, within which the auditory Nerve lieth, but hath a Part of the auditory Nerve spread upon it too. It is manifest that this is the true Process of Hearing; because if the Membrane be mov'd, you may see all the Bones move at the same Time, and work the Base of the Stapes up and down in the Fenestra Ovalis, as I shewed in this Chapter, Note (d), concerning the Mole; and as it may be feen in other Ears carefully opened, if the Parts remain in fitu:

(w) I do not confine the Labyrinth to the Canales Semicirculares, or any other Part, as the elder Anatomists seem to have done, who by their erroneous and blind Descriptions seem not

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vey the carious and admirable Structure of the Ve. flibulum, the Semicircular Canals (x), and Cochlea; particulary the artificial Gyrations, and other fingular Curiofities observable in the two latter.

But I shall not expatiate on these recluse Parts; only there is one special Contrivance of the Nerves ministring to this Sense of Hearing, which must not be passed by and that is, the Branches of one of the auditory Nerves (y), spread partly to the Muscles of the Ear, partly to the Eye, partly to the

Tongue

well to have understood these Parts; but with those much more curious and accurate Anatomists, Monsieur de Vernay, and Dr. Villition; under the Labyrinth, I comprehend the Canalu Semicirculares, and the Cockien, rogether with the intermediate

Cavity, called by their the Vellbulum, a landing

(x) In the semiconcular Comals, two Things deserve to be noted. 1. That the three Canals are of three different Size, Major, Minor, and Minimus. 2. Although in different subjects, they are frequently different; yet in the same Subjects, they are constantly the same. The Reason of all which, together with their Uses, Vallatus ingeniously thinks is, that a Part of the tender auditory Norve is lodged in these Canals, so they are of three Sizes, the better to suit all the Variety of Tones; some of the Canals suiting some, and others, other Tones. And although there be some Difference as to the Length and Size of these Canals, in different Persons; yet, less there should be any discord in the auditory Organs of one and the same Man, those Canals are always in exact Conformity to one another in one and the same Man. V. Valsal, with sort. Ch. 3. Sect. 7. and Ch. 6. Sect. 4. 9.

(y) Hic posterior Nervus extra cranium delatus, in tres ramos dividitur, qui omnes motibus patheticis—inserviunt. Primus—musculis Auris impenditur. Proculdubio hujus actione efficitur, ut ammalia quavis, à subito soni impulsu, aures, quasi sonum nimis ein transeuntem captaturas erigant. Ramus alter—versus utrumque oculi angulum surculos entititi: qui musculis palpebrarum attokentibu inseruntur; quorum certé munus est ad subitum soni appulsum oculis consestim aperire, eosque velut ad Excubias vocare.—Tertius—ramus versus Lingua radisem descendens, musculis ejus & ossis Hyceideos distribuitur, adcòque organa quadam vocis edenda attuat. & ... Willist

Cereb. Anat. c. 17.

(2) Hu-

(z) Huju

Tongue and Instruments of Speech, and inosculated with the Nerves to go to the Heart and Breast. By which Means there is an admirable and useful Consent between these Parts of the Body; it being natural for most Animals, upon the Hearing any unsouth Sound, to erect their Ears, and prepare them to catchevery Sound; to open their Eyes (those constant faithful Centinels) to stand upon their Watch; and to be ready with the Mouth to call out, or uter what the present Occasion shall dictate. And accordingly it is very usual for most Animals, when urprized, and terrify d with any Noise, presently to hriek and cry out.

But there is besides this, in Man, another great Is of this nervous Commerce between the Ear and south; and that is, (as one of the best Authors on his Subject expressent it) (2), "That the Voice may correspond with the Hearing, and be a kind of Echo thereof, that what is beard with one of the two Nerves, may be readily expressed with

the Voice, by the Help of the other.

Thus much shall suffice to have spoken concern-

ng the Organ. Let us,

II. Take Notice of the Object of this admirable ense, namely, Sound; and so conclude this Chaper. I shall not here enquire into the Nature and Properties of Sound, which is in a great Measure inticate, and hath puzzelled the best Naturalists: Neither shall I shew how this admirable Effect of the Divine Contrivance, may be improved to divers Uses

⁽z) Hujusmodi Nervorum conformatie in Homine usum alium insiguierem prastat, nempe ut Vex, &c. Willis bid.

K. 2 (aa) Among

Uses [aa] and Purposes in Humane Life; but my Bufiness will be to shew that this Thing, of so ad. mirable Use in the animal World, is the Work of

(aa) Among the Uses to which the Wit of Man hath employ'd Sounds, we may reckon the Instruments useful inconvocating Assemblies, managing Armies, and many other Oc. cafions, wherein Bells, Trumpets, Drums, Horns, and other founding Instruments are used; the Particularities of which it would be tedious to recount: As that the biggest Bell in Europe is reckoned to be at Erfurt in Germany, which they far may be heard twenty four Miles; with much more to the fame Purpose. I shall therefore only for a Sample take notice of the Speaking-Trumpet; the Invention of which is commonly ascribed to our eminent Sir Samuel Morland; but was more probably Ath. Kircher's; at least he had contrived such an Instrument, before Sir Samuel hit upon his. Kircher in his Phonurg. faith, The Tromba published last Year in England, he had invented twenty four Years before, and published in his Misurgia; that Jac. Albanus Ghibbesius, and Fr. Eschinardus a. scribe it to him; and that G. Schottus testifieth he had such an Instrument in his Chamber in the Roman College, with which he could call to, and receive Answers from the Porter. And confidering how famed Alexander the Great's Tube was which is faid might be heard 100 Stadia, it is somewhat strange that no Body sooner hit upon the Invention. Of this Stentorophonick Horn of Alexander, there is a Figure preserved in the Vatican, which for Curiofity fake, I have from Kirch represented in Fig. 3. He faith its Diameter was five Cubin, and that it was suspended on a Supporter.

For the Make of the Speaking-Trumpet, and the Reason why it magnifies Sounds, I shall refer to Kircher; especially to Sir Samuel Morland's Tuba Stentorophonica, Published in 1672.

Kircher saith, he took one of these Trumpets of fisten Palms length, along with him to the Mons Eustachianus, where he convocated 2200 Persons to Prayers, by means of the unufual Sound, at two, three, four, and five Italian Miles Di-

With these Bellowing-Trumpets, I shall join some Bellowing Caves for the Reader's Diversion. Ol. Magnus describes 1 Cave in Finland, near Viburg, called Smellen, into which, if Dog, or other Living Creature be cast, it fends forth fo dread ful a Sound, that knocks down every one near it. For which Reason they have guarded the Cave with high Walls, to

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prevent c. 4. S with a Miles] Cucumer and a g Country a great thern P

fundi [im tantum b remigio, toque dier tatis com ingressu c opificio fi quasi sub also Cha (bb). T

Air. In at the I scarce b compre Compre tried m Experin No. 321 Neith

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Condent is evider Eminen Story of Sublimita periri vol mum terr altior cau loco a via

God. And this will appear, let the subject Matter of Sounds be what it will; either the Atmosphere (bb) in Gross, or the ætherial Part thereof. or foniferous Particles of Bodies, as some fancy, or

prevent the Mischiefs of its Noise. Vid. Ol. Magn. Histor. 1. 11. c. 4. Such another Peter Martyr faith is in Hispaniola, which, with a small Weight cast into it, endangers Deafness at five Miles Distance. And in Switzerland, Kircher saith, in the Cucumer-Mountain is a Pit that sends out both a dreadful Noise and a great Wind therewith; and that there is a Well in his Country 3000 Palms deep, whose Sound is equal to that of a great Gun. Vid. Kirch. Phonurg.

Ol. Magnus speaking of the vast high Mountains of a Northern Province, call'd Angermannia, faith, Ubi bases eorum in profundissimo gurgite stantes, casu aliquo, vel proposito Nauta accesserint, tantum korrorem ex alta fluctuum collisione percipiunt, ut nisi pracipiti remigio, aut valido vento evaserint, solo pavore ferè exanimes fiant, multoque dierum curriculo, ob capitis turbationem, pristina mentis, & sanitatis compotes vix evadant. Habent bases illorum montium in fluctuum ingressu 😌 regressu tortuosas rimas, sive scissuras, satis stupendo natura opificio fabricatas, in quibus longa varagine formidabilis ille Sonitus quasi subterraneum tonitru generatur. Ol. Magn. 1. 2. c. 4. See alfo Chap. 12.

(bb). That the Air is the Subject, or Medium of Sound, is manifest from the Experiments in rarefied and condensed Air. In an unexhausted Receiver, a small Bell may be heard at the Distance of some Paces; but when exhausted, it can scarce be heard at the nearest Distance: And if the Air be compressed, the Sound will be louder, proportionably to the Compression or Quantity of Air crouded in, as I have often tried my felf, and may be feen in Mr. Hawksbee's curious Experiments, p. 97. Also his Experiments in Phil, Trans.

No. 321.

Neither doth this succeed only in forced Rarefactions and Condensations of the Air, but in such also as are natural; as is evident from David Freedlichius in Varenius, upon the highest Eminencies of Carpathus, near Kesmarckt in Hungary. The Story of Frædlichius is this, Ego Mense Junii 1615. tum adolescens. sublimitatem borum montium, cum duobus comitibus Scholaribus, experiri volens, ubi, cum in prima rupis vertice, magno labore, me summum terminum affecutum effe putarem, demum fefe obtulit alia multo altior cautes, ubi perpasta eaque vacillantia saxa (quorum unum, se loco à viatore dimovetur __aliquot centena ____rapit, & quidem

134

whatever else the Philosophers may think it. For who but an Intelligent Being, what less than an

Omni-

tanto cum fragore, ut illi metuendum fit ne totus Mons corruat, enmque obruat) enixus effem, iterum alia sublimior prodiit, &c. dones fummo vita periculo ad fupremum cacumen penetraverim. Ex decli. pioribus montibus cum in subjectas valles, -nil nifi obscuran nottem, aut coruleum quid, inftar profundi aeris, quod vulgo sudum colum appellatur, observare potui mibique videbar, fi de monte cade. rem, non in terram, sed recte in solum me prolapsurum. Nimia enim declivitate, species visibiles extenuata & babetate fuerunt. Cum però altiorem montem peterem, quasi intra nebulas densissi mas barsbam-Et cum non procul à summo vertice essem de sublimi quiescens profpexi & animadverti ils in locis, ubi mibi antea videbar intra nebulas bafisse, compactas atque albas sese movere nubes, supra quas, per aliquot milliaria, & ultra terminos Sepufi commodus mibi profpectus patuit. Alias tamen etiam nubes altiores, alias item bumiliores, necnon quasdam equaliter à terra distantes vidi. Atque binc tria intellexi, 1. Me tum transivisse principium media Aeris regionis. 2. Distantiam nubium à terra, non esse aqualem. - 3. Distantiam nubium - non 72 Mill. Ger. ut guidam - fed tantum dimidiatum Mill. Ger. In fummum montis verticem cum pervenissem, aded tranquillum & subtilem aerem ibi offendi, ut ne pili quidem motum fentirem, cum tamen in depressionibus ventum vehementem expertus sim : unde collegi summum cacumen iffius montis Carpathici ad Mill. Germ. à radicibus suis imis exsurgere, & ad supremam usque aeris regionem, ad quam Venti non ascendunt, pertingere. Explost in ea summitate Sclopetum : quod non majorem sonitum primo pra se tulit, quam si ligillum vel bacillum confregissem; post intervallum autem temporis murmur prolixum invabuit, inferioresque montis partes, convalles & sylvas opplevit. Descendendo per nives annofas intra convalles, cum iterum Sclopetum exonerarem, major & borribilior fragor, quam ex tormento capacissimo inde exoriebatur: binc verebar ne tatus mons cancusus mecum corrueret: duravitque bic fonus per semiquadrantem bor a usque dum abstrufifimas cavernas penetraffet, ad quas aer undique multiplicatus refiliit. In his celsis montibus, plerumque ningit grandinatve media eftate, quoties nempe in subjetta & vicina planitie pluit, uti boc ipsum expertus sum. Nives diversorum annorum ex colore & cortia duriore dignosci possunt. Varen. Geogr. Gen. l. 1. c. 19. Prop. ult.

This Story being diverting, and containing divers Things remarkable, I have chosen to note the Whole of it (although fomewhat long) rather then fingle out the Passages only which relate to the diminishing of the Sound of his Pistol,

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the Ra here; ar Reperc mptick (But 'tis Sound, ll under ard, but ourth de otes, w lersenne fa one or 1 ade in t draul. Having ere is an er prove ound, viz oifes ma ofeabov riment the Divi m of the as fo ver ade him s Bell, a 1. 2. Ten

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Omnipotent and Infinitely Wise God could contrive, nd make such a fine Body, such a Medium, so is sceptible of every Impression, that the Sense of learing hath occasion for, to empower all Animals of express their Sense and Meaning to others; to nake known their Fears, their Wants, their Pains and Sorrows in melancholick Tones; their Joys and Pleasures in more harmonious Notes; to send neir Minds at great Distances (co), in a short Time (dd),

the Rarity of the Air at that great Ascent into the Atmohere; and the magnifying the Sound by the Polyphonisms Repercussians of the Rocks, Caverns, and other Phono-

mptick Objects below in the Mount.

But 'tis not the Airalone that is capable of the Impressions Sound, but the Water also, as is manifest by striking a ell under Water, the Sound of which may plainly enough be eard, but it is much duller, and not so loud; and it is also sourth deeper, by the Ear of some great Judges in Musical otes, who gave me their Judgments in the Matter. But inspense faith, a Sound made under Water, is of the same one or Note, if heard under Water; as are also Sounds ade in the Air, when heard under Water. Vielt Mersen. draul.

Having mentioned the hearing of Sounds under Water, ere is another Curiofity worth mentioning, that also farer proves Water to be susceptible of the impressions of ound, viz. Divers at the Bottom of the Sea, can hear the oises made above, only consusedly. But, on the contrary, ose above cannot hear the Divers below. Of which an Extiment was made, that had like to have been satal. One the Divers blew an Horn in his Diving-Bell, at the Botm of the Sea; the Sound whereof (in that compressed Air) as so very loud and irksome, that stunned the Diver, and ade him so giddy, that he had like to have dropt out of s Bell, and to have been drowned, Vid, Sturmii Colleg, Cur, I. 2. Tentam. 1.

(a) As to the Distance to which Sound may be sent, havg some doubt, whether there was any Difference between e Northern and Southern Parts, by the Favour of my arned and illustrious Friend Sir Henry Newton, her late Masty's Envoy at Florence; I procured some Experiments to Time (dd), in loud Boations; or to express their Thoughts near at hand with a gentle Voice, or in fecret Whispers! And, to say no more, who less than the same most Wise and Indulgenr Creator

could

be made for me in Italy. His most Serene Highness the Gran Duke, was pleased to order great Guns to be fir'd for this purpose at Florence, and Persons were appointed on purpose to observe them at Leghorne, which they compute is no less than 55 Mile in a strait Line. But notwithstanding the Country between being fomewhat hilly and woody, and the Wind also was m favouring, only very calm and still, yet the Sound was plain ly enough heard. And they tell me, that the Leghorne Gun are often heard 66 Miles off, at Porto Ferraro; that when the French bombarded Genoa, they heard it near Leghorne, 90 Miles distant; and in the Messina Insurrection, the Guns were heard from thence as far as Augusta and Syracuse, about 100 Italia Miles. These Distances being so considerable, give m reason to suspect, that Sounds fly as far, or nearly as far, i the Southern, as in the Northern Parts of the World, notwith standing we have a few Instances of Sounds reaching farther Distances. As Dr. Hearn tells us of Guns fired at Stocklomin 1685, that were heard 180 English Miles. And in the Date War, 1672, the Guns were heard above 200 Miles. Vid. Ph Trans. No. 113. Also there is this farther Reason of Suspicion that the Mercury in the Barometer riseth higher without that within the Tropicks, and the more Northerly, still the high er, which may increase the Strength of Sounds, by Note (16).

(dd) As to the Velocity of Sounds, by Reason the mo celebrated Authors differ about it, I made divers nice Expe riments my felf, with good Instruments; by which I tound 1. That there is some, although a small Difference in the Velocity of Sounds, with or against the Wind; which also 2. Augmented or diminished by the Strength or Weakness the Wind. But that nothing else doth accelerate or retard not the Differences of Day or Night, Heat or Cold, Summ or Winter, Cloudy or Clear, Barometer high or low, 3. That all kinds of Sounds have the same Motion, whether they be loud or languid, of Bells, Guns, great or finall, or a other fonorous Body. 4. That they fly equal spaces in equal Times. Fifthly and Laftly, That the Mean of their Flight is at the Rate of a Mile in 9 half Seconds and a quarter, 1142 Feet in one Second of Time. Vid. Phil. Trans. Ibid,

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the C of the Matte off, could form such an OEconomy, as that of Melody and Musick is; That the Medium should (as I said) so readily receive every Impression of Sound, and convey the melodious Vibration of every musical String, the harmonious Pulses of every animal Voice, and of every musical Pipe; and the Ear be as well adapted, and ready to receive all these Impressions, as the Medium to convey them: And lastly, that by Means of the curious Lodgment, and Inosculations of the auditory Nerves before-mentioned, the Orgasms of the Spirits should be allay'd, and Perturbations of the Mind, in a great Measure quieted and stilled (ee): Or to express it in the Words

(ee) Timothy a Musician could excite Alexander the Great to Arms with the Phrygian Sound, and allay his Fury with another Tone, and excite him to Merriment. So Ericus King of Denmark, by a certain Musician, could be driven to such a Fury, as to kill some of his best and most trusty Servants. More of this Power of Musick over the Affections, may be seen in Ath. Kirch. Phonurg. L. 2. Sett. 1. Also in Is. Vossius de Poematum cantu. & Rythmi viribus.

And not only upon the Affections, but also on the Parts of the Body, Musick is able to exert its Force, as appears from the Gascoigne Knight, Cui Phormingis sono audito Vesica statim ad Urinam reddendam vellicabatur. Such another we have in No. 1. Ephem. Nat. Curiof. Observ. 134. Also Morhoff de Scyph. vitr. per cert, buman, vocis sonum fracto: where there is not only the Account of the Dutchman at Amsterdam, one Nich. Peter, that brake Romer-Glasses with the Sound of his Voice; but also divers other Instances of the Powers and Effects of Sound. But to the Story of the Gascoigne Knight, Mr. Boyle, from Scaliger, adds a pleafant Passage, That one he had disobliged. to be even with him, caused at a Feast, a Bag-pipe to be played, when he was hemmed in with the Company; which made the Knight be-piss himself, to the great Diversion of the Company, as well as Confusion of himself. Boyle's Essay of the Effect of Lang. Motion. In the same Book are other Matters that may be noted here. One whose Arm was cut off, was exceedingly tormented with the discharge of the

great Guns at Sea, although he was at a great Distance on Land. And a great Ship-Commander observed his wounded Men, with broken Limbs, fuffered in like manner at the Enemies Discharges. An ingenious Domestick of his own would have his Gums bleed at the tearing of Brown-Paper. And an ingenious Gentleman of Mr. Boyle's Acquaintance confeffed to him, that he was inclined to the Knight of Gascoigne's Diftemper, upon hearing the Noise of a Tap running. The dancing to certain Tunes, of Persons bit with the Tarantula he was affured by an ingenious Acquaintance at Tarentum who faw feveral, among the rest a Physician, affected with that Diftemper. And many other Accounts of this kind, feemingly crebible, are related in Morboff, Kircher, and many others; although Dr. Cornelio questions the Matters of Fact relating to the Cure of the Tarantula-bite, in Phil. Trans. No. 83. Mr. Boyle also faith, a fober Musician told him, he could make a certain Woman weep, by playing one Tune, which others would be little affected at. And he faith, that he himself had a kind of shivering at the repeating two Verses in Lucan. And I add, that I very well know one to have a fort of Chill about his Pracordia and Head, upon reading or hearing the 53d Chapter of Isaiah; as also David's Lamenta.

tions for Saul and Fonathan, I Sam, i.

Neither are our own Minds and Bodies only affected with Sounds, but manimate Bodies are fo alfo. Of which many Stories may be met with in Kircher, particularly a large Stone that would tremble at the Sound of one particular Organ-Pipe; in Morhoff also, who among many other Relations hath this, Memint cum ipfi [clarif, Willifio] de experimento Vitri per vocen fracti narrarem, ex eo audivisse, quod in edibus Musicis sibi vicinis aliquoties collapsum pavimentum fuerit; quod ipse sonis continuis adscribere non dubitavit. Morhoff, cap. 12. Mersenne also, among many Relations in his Harmon, and other Books, tells a far more probable Story, of a particular Part of Pavement, that would shake, as if the Earth would open, when the Organs played, than what he relates about Antipathy, in his Qual. Comment, in Genef. viz. That the Sound of a Drum made of a Wolf's Skin, will break another made of Sheep's Skin: That Hens will fly at the Sound of an Harp strung with Fox-Gut-Strings, and more to the same purpose. Mr, Boyle also, in his last cited Book tells us, Seats will tremble at the Sound of Organs; and that he hath felt his Hat to do fo too under his Hand, at certain Notes both of Organs, and in Difcourse, that he tried an Arch that would answer to C fa-ut, and had done fo an 100 Years; and that an experienced Build-

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ient in er told him any well-built Vault will answer some determi-

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Words of the last-cited famous Author (ff, "That "Musick should not only affect the Fancy with Delight, but also give Relief to the Grief and Sadness of the Heart; yea, appeale all those turbulent Passions, which are excited in the Breast by an immoderate Ferment, and Fluctuation of the Blood".

And now, who can reflect upon all this curious Apparatus of the Sense of Hearing, and not give he Great Creator his due Praise! Who can survey Il this admirable Work, and not as readily own to be the Work of an Omnipotent, and Infinitely Wise and Good GOD (gg), as the most artful selodies we hear, are the Voice or Performances of a living Creature!

ate Note. And at Eastbury-House near Barking, I my self iscovered the Porch, (having firm Brick-Walls,) not only to und when struck on the Bottom, but also to give almost as und a Sound, when I sounded the same Note with my Voice.

(ff) Willis, ubi supra.
(gg) Ille Deus est—qui non calamo tantum cantare, & agresse, que inconditum carmen ad aliquam tantum oblectationem modulari cuit, sed tot artes, tot vocum varietates, tot sonos, alios spiritu nostro, los externo cantu edituros commentus est. Senec. de Benef. 1. 4.
p. 6.

CHAP. IV.

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Of the Sense of Smelling.

THIS Sense I shall dispatch in less Compass than the two last, because its Apparatus (although sficiently grand and admirable, yet) is not so ultiplicious as of the Eye and Ear; it being sufficient in this Sense, that the odoriferous Essluvia of Bodies

Bodies (a) can have an easy, free Passage to the

olfactory Nerves, without the Formalities of Re-

fractions, and other Preparations necessary to the

Perfection of the two former Senses. Accordingly,

the All-wife Creator hath made fufficient Provision

for the Reception of Smells, by the Apertures of

the Nostrils (b); made not of Flesh, or Bone, but

cartilaginous, the better to be kept open, and

withal, to be dilated or contracted, as there is Oc-

casion: For which Service it hath several proper

And foralmuch as it is by Breathing (d), that

the odorant Particles are drawn in, and convey'd

to the Senfory; therefore there is a very wife Pro-

vision made in the Lamina, with which the upper

Part of the Nose is barricaded, which serve to two

excellent Uses: Partly, to fence out any noxious

Substances from entering the breathing Passages in

and curious Muscles (c).

BOOK IV.

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(f) I

(a) A Piece of Ambergrease suspended in a Pair of Scales, that would turn with a very small Part of a Grain, lost nothing of its Weight in 3 Days and half; neither did Allafatida in 5 Days and half: But an Ounce of Nutmegs lost; Grains and half in 6 Days; and Cloves 7 Grains and four fifths. Boyle's Subtil. of Effluv. c. 5.

(b) Nares, eò quod omnis Odor ad superiora fertur, recte sursum sunt: Et quod Cibi & Potionis judicium magnum earum eft, non fine causa vicinitatem Oris secute sunt. Cic. de Nat. Deor. 1. 2. c. 56.

(d) Odorem non aliud, quâm infectum Aera, intelligi posse.

Nat. Hift. l. 9. c. 7.

(e) For

⁽c) Had not the Contriver of Animal Bodies been minded that his Work should have all the Signatures of Accuracy, this Sense might have been performed with a bare Aperture of the Nose; but that nothing might go imperfect out of his Hand, he hath made a Part of the Nose easily moveable, and given a Set of Muscles to lift up, and open and shut the Noftrils; and so adjust it to every Occasion of this Senie.

our Sleep, or when we cannot be aware (e); and partly, to receive the Divarications of the olfactory Nerves, which are here thick spread, and which do by these Means meet the Smells entring with the Breath, and striking upon them.

And accordingly, the more accurate this Sense is in any Animal, the longer we may observe those Lamina are; and more of them in Number folded up, and crouded together, to contain the more nervous Filaments, and to detain and fetter the odoriferous Particles in their Windings and Tur-

And an admirable Provision this is, which the Great Creator hath made for the Good of Brute Creatures (f); the chief Acts of many of whose Lives are perform'd by the Ministry of this Sense. In Infects, and many other Creatures, it is of great Use in the Propagation of their Kind; as particularly in helping them to fafe and convenient Places for the Incubation of their Eggs, and breeding up

⁽e) For a further Guard against the Ingress of noxious Things, the Vibriss, or Hairs placed at the Entrance of the Nostrils serve, which, in some Measure stop the Entrance of Things improper, or, however, give Warning of them; but at the same Time allow an easy Passage to the Breath and Odours.

⁽f) Multo praclarius emicat [Olfactus] in brutis animalibus, quam in homine: ista namque boc solo indice, berbarum, aliorumque corporum prius ignotorum virtutes certissime dignoscunt, quin & victum suum absentem, vel in abstruso positum, Odoratu venantur, ac facillime invefligant. Quod autem minus sagaces sunt hominum nares, illud non facultatis hujus abusui (prout nonnulli volunt) ascribi debet, verum in causa est ipsius Organi defettus: boc enim circa vittus bumani criteria (ubi ratio, & intellectus adjunt) non ita accuratum requiritur : Propterea enim inferiores potentiæ in homine, a natura minus perfette existunt, ut superiorum cultui & exercitio relinqueretur locus. Willis de Anim. Brut. cap. 13. (g) Thus

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their Young. Others are by the Accuracy of this Sense, of Use to Mankind, which would be otherwise of little or no Use (g). And most of the irrational Animals, Birds, Beasts, and creeping Things, do, by their Smell, find out their Food; some at great Distances, and some at Hand. With what Sagacity do some discover their Food in the midst of Mud and Dirt (b)? With what Curiosity do the herbaccous Kind pick and chuse such Plants as afford them wholsome Food, or sometimes such as are Medicinal (i), and refuse such as would hunt and destroy them? And all by the Help principally, if not only, of the Smell, assisted by its near Ally the Taste. Of which I shall in the next Place speak very briefly.

The Sagacity of Hounds is prodigious; of which fee an

Instance in Book IV. Chap. 11. Note (bbb).
(b) See Book VII. Chap. 2. Note (e).

(1) Vide Plin. Hift. Nat. 1. 8. cap. 27. Que animalia quas hosbas oftenderunt;



⁽g) Thus the chief Use of Hounds is to hunt; and other Dogs, to be a Watch and Guard to our Houses by Night. For which Services (particularly in Hounds) their Osfattory Nerva are not only remarkably large, (like as they are in other Brutes,) but their Branches and Filaments are, in the Lamina of the Nostrils, both more and larger than I have seen in any other Creature whatsoever. Also there are more Convulsions of the Lamina than I ever remember to have sound in any other Animal.

ni zi no CHAP. V. Of the Tafte (a) : util odt

IN this, as in the last Sense, we have an Apparatus abundantly sufficient to the Sense; Nerves uriously divaricated about the Tongue (b), and Mouth to receive the Impressions of every Gusto; and these Nerves guarded with a firm and proper Tegument to defend them from Harms; but withal, o perforated in the papillary Eminences, as to give free Admission to Tastes. But

(a) To 3 ann Tor yuner, &c. Saporum genera, ___ dulcis, pinuis, austerus, acerbus, acris, salfus, amarus, acidus. Theophr. de auf. Plant. 1. 6. c. 1. What may be the Caufe of the differnce of Talles, he faith is hard to affign, worses out vois aden, &c. Utnum affectionibus Senfuum am figuris, quibus finuli constant, ut Domocritus conset, id. ib. Anuscelo 3, &c. emocritus-dulcem esse saporem qui rotundus; acerbum qui figura agna; asperum qui multis angulis, &c. id. ib. &c. But of the liversities and Causes of Tastes, see Dr. Grew, Lett. 6. and r. Willis de Anim. Brut. C. 12.

(b) Intellectus Saporum oft cateris in prima lingua: Homini & in

alato. Plin. 1. 11. c. 37.

The Opinions of Anatomists concerning the Organ of Take, re various. Baubin, T. Bantholin, Bartholette, Vestinge, Deusinge, c. place it in the laxer, fleshy Parts of the Tongue. Our mous Wharton, in the Gland at the Root of the Tongue; aurentius in the thin Tunick covering the Tongue; but the arned Malpighi with great Probability concludes, because he outward Cover of the Tongue is perforated, under which e papillary Parts, (of which Mr. Cowper hath very good luts in his Anat. Tab. 13.) that in these the Taste lieth. Malghi's Words are, Quare cum dictis meatibus insignibus occurrant spillaria corpora, probabileus est in his ultimo, ex subintranti sapido umore titillationem, & mordicationem quandam fieri, qua Gustum eftiat. Malpig. Op. Tom. 2. De Lingua, pag. 18.

Pracipium ac fere solum Gustatûs organon est Lingua; cui aliquanus subibs ure tamen Palatum, & superior Gula pars consentiunt: in nnibus cerò fibra nervosa immediata sensionès instrumenta sunt. Quare

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But I shall say no more of this Sense; only a Word or two of its Consent with the Smell, and the Situation of them both: Their Situation is in the most convenient Place imaginable, for the Difcharge of their Offices; at the first Entrance (c) in the Way to the grand Receptacle of our Food and Nourishment; to survey what is to be admirted therein; to judge between what is wholsome, and fit for Nourishment, and what is unfavoury and pernicious. And for this End, the All-wife Creator seems to have established a great Consent between the Eye, the Nose, and Tongue, by ordering the Branches of the same Nerves (d), to each of those three Parts; as also indeed, to divers other Parts of the Body, which I may have Occasion to mention in a more proper Place (e). By which Means, there is all the Guard that can be, against pernicious Food; forasmuch, as before it is taken into

observare est. Linguam pra alia quavis parte insigniter fibrosam est. etiam textura valde porosa constare, in eum nempe finem, ut particule rei sapida copiosius ac penitius intra Sensorii meatus admittantur-Nervi autem qui fibris Lingua densissime intertextis famulantur, " Saporum impressiones to moure ateduque communicant, sunt-Nervi è paribus tum quinto, tum nono; & ubique cum densa propagnum ferie per totam ejus compagem distributi, Willis ibid.

(c) Gustatus, qui sentire corum quibus vescimur genera debet, balitat in ea parte Oris, qua esculentis & poculentis iter natura patefuit, Cic. de Nat. Deor. 1. 2. c. 56. Vide quoque supra, Note

(e) See Book V. Chap. 8.

⁽d) Multa hujus [quinti Paris] Nervi propagines Masticationis peri destinantur; ideoque quoniam alimenta ingerenda non modo Gusti, ast etiam Olfactus & Visus examen subive debent, ab eodem Nera, cujus rami ad Palatum & Fauces missi, Manducationis negotium per gunt, propagines alia, velut exploratrices, ad Nares & Oculos ferunti, nempe ut ifthec alierum sensuum organa, etiam ad objecta Gustis me lius dignoscenda probationum auxiliis quibusdam inftruantur. Will Nerv. Descrip. & Usus. cap. 22. (a) Mal

into the Stomach, it is to undergo the Trial of three of the Senses; the Scrutiny of the Eye, the strict Surveyor of its outward Appearance; and the Probation of the Smell and Tafte, the two feverest Judges of its natural Constitution and Compolition.

CHAP. VI. Of the Sense of Feeling (a).

HAVING spent so much Time upon the other - Senses, and therein given such ample Proofs of the Infinite Creator's Wifdom; I shall but briefly take Notice of two Things relating to this last Senfe.

One is its Organ, the Nerves. For as all Senfation

These Observations of Malpighi, our late curious and diligent Mr. Cowper hath confirmed, and given us very elegant Cuts both of the Skin, and the Papilla, and the Nerves, Glands, &c, under it, from Microscopical Observations. Vide Cowper's Anat. Introd. and Tab. 4.

(b) Although

⁽a) Malpighi is of this Opinion, that as Tafte is performed by the Papilla in the Tongue, so is Feeling by fuch like Papilla under the Skin. From feveral Diffections, and other Obfervations, he thus concludes, Ex bis & similibus videbatur animus abundė certior redditus, earundem Papillarum pyramidalium copiam, quas alias in Lingua descripsi, in locis pracipuė acquistiori Tattui dicatis reperiri, codem progigni nervoso & cuticulari corpore, simulque cirsumvolvi reticulari involucro, & extimam cuticulam, veluti ultimum terminum attingere. - Microscopio quilibet in manus derso pro sudore rificia quadam miro ordine dispersa intueri potest, circa qua frequentia quadam capitula assurgunt; hac vero sunt Papikarum fines, dum à sute assurgentes interpositum superant rete, simulque extimam cuticulam. Hac repetitis sectionibus deprehendi; ex quibus non improbabiliter deducam, sicuti ex elatoribus—papillis—in Lingua, Gustûs Organon elicitur,-ita ex copiofa harum Papillarum congerie-in organis, ubi maxime animalia Taclus motione afficiuntur, ___adaquatum Tastus organum sufficienter baberi. Malpig. de externi Tact. Org. p. 26. Conful, quoque ejufd. Vit. p. 28.

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tion is performed by the Nerves (b), and indeed the other Senses (performed by Nerves) are a Kind of Feeling; so is this Sense of Feeling performed by Nerves likewise, spread in the most incomparable, curious Manner throughout the whole Body. But to describe their Origin in the Brain, and Spinal-Marrow, their Ramifications to all the Parts; their Inosculations with one another; and other Matters; whereby not only the Sense of Feeling is performed, but also animal Motion, and admirable Consent and Harmony of all the Parts of the Body is effected: [To describe, I say, these Things,] would take up too much Time, and I have already, and shall, as I go along, give some Hints thereof.

The other Thing I shall take Notice of, is, the Dispersion of this Sense throughout the Body, both without and within. The other Senses, I have observ'd, are seated in the very best Place for the Relief and Comfort, the Guard and Benefit of the Animal. And for smuch as it is necessary to the Being and Well-being of the Body, that every Part should be sensible of Things safe, or Things prejudicial to it self; therefore, it is an admirable Contrivance of the Great Creator, to disperse this Sense of Feeling throughout every Part (c); to distinguish

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⁽b) Although the Eye be the usual Judge of Colours, yet some have been able to distinguish them by their Feeling. Quidam fust qui venit ad M. Duc. Hetruriæ aulam qui colores per Tactum cognoscebat. Pro experimento velum sericum, uniformiter textum, & pluribus coloribus tinctum, offerebatur, & veraciter de colore in singulis partibus judicabat. Grimald. de Lum. & Col. prop. 42. sect. 59.

⁽c) Tactus autem teto corpore aquabiliter fusus est, ut omnes illu, erinosque nimios & frigoris, & caloris appulsus sentire possimus. Cic.

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between Pleasure and Pain; Things salutary, and Things hurtful to the Body.

Thus in the five Senses of Animals, we have an OEconomy worthy of the Creator, and manifestly demonstrating his Power, Wisdom and Indulgence. For whether we consider the Mechanism of the Organs, or the great Use and Convenience of each Sense, we find it noble and grand, curious and artisticial; and every way worthy of its Infinite Marker, and beyond the Wit and Power of any Thing but a GOD: And therefore we must even deny our Senses, by denying them to be God's handy-

And now from those chief Machines of Animal Performances and Enjoyments, the five Senses; let us pass to another Thing in common to all the sensitive Creatures, which is Respiration.

Tactus sensus omnibus est, etiam quibus mulus alius; nam & Ostreis; & terrestribus Vermibus quoque. Existimaverim omnibus sensum & Gustatûs esse. Cur enim alios alia sapores appetunt? in que vel pracipua Natura architectio. Plin. Nat. Hist. 1, 10. c. 71.

CHAP. VII. Of Respiration.

OF all the Acts of Animal Life, this is one of the chief, and most necessary. For whatsoever hath Animal Life, hath also the Faculty of Respiration, or somewhat equivalent thereto (a). Indeed

⁽a) The Uses affign'd to Respiration by all the Anatomists before Malpighi's Discoveries of the Structure of the Lunguage so various, and many of them so improbable, that it would be frivolous to recount them. But the more eminent moderate Anatomists assign these Uses. Willis thus sums up his Opi-

BOOK IV. Of Respiration. 148 deed so congenial is this with Life, that Breath

and Life are in Scripture Phrase and Common

Speech

nion, Pracipua Pulmonum functio, & usus sunt, Sanguinem & aerem per totas partium compages, intimosque recessus, atque du us quosque minutissimos traducere. & ubique invicem committere; in eum nempe finem, ut fanguis venosus à circuitu redux, & chymo recenti dilutus tum perfectius misceatur & velut subigatur, tum potissimum ut secundum omnes suas partes ab aere nitroso de novo accendatur. Pharmaceut. P. 2. S. 1. C. 2. Sect. 2. Mayow faith rightly, that one grand Use of Expiration is, Ut cum aere expulso, etiam vapores i sanguine exhalantes, simul exsufflentur. And as for Inspiration that it conveyeth a nitro-aerial Ferment to the Blood, to which the Animal-Spirits are owing, and all Muscular-Mo-Mayow de Respir. p. 22, &c. mea Edit.

Somewhat of the Opinion of these two last cited, if I mistake not (it being long fince I read their Tracts, and have them not now at Hand,) were Ent, Sylvius, Swammerdam, Diemerbroek, and my Friend Mr. Ray, in an unpublished Tract

of his, and his Letters now in my Hands.

But our Dr. Thurston, for good Reasons, rejects these from being principal Uses of Respiration, and thinks, with great Reason, the principal Uses to be to move, or pass the Blood from the right to the left Ventricle of the Heart. Upon which account Persons hanged, drowned, or strangled by Catarrhs, fo fuddenly die, namely, because the Circulation of their Blood is stopped. For the same Reason also it is, that Animals die so soon in the Air-Pump. Among other Proofs he instanceth in an Experiment of Dr. Croon, Profes. Greft, which he made before our R. S. by strangling a Pullet, fo that not the least Sign of Life appear'd; but by blowing Wind into the Lungs through the Trachea, and fo fetting the Lungs a-playing, he brought the Bird to Life again. Another Experiment was once tried by Dr. Walter Needham, before Mr. Boyle, and others at Oxford, by hanging a Dog, to that the Heart ceafed moving. But hastily opening the Dog, and blowing Wind into the Ductus Pecquetianus, he put the Blood in Motion, and by that Means the Heart, and forecovered the Dog to Life again. V. Thurston de Respr. Us. p. 60, and 63. mea Edit.

Such an Experiment as Dr. Croon's my Friend, the late just ly renowned Dr. Hook shewed also our R. S. He cut away the Ribs, Diaphragm, and Pericordium, of a Dog; also the Top of the Wind-Pipe, that he might tie it on to the Nese of a

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1, & 1 But (like Time alfo ca Pair of Bellows; and by blowing into the Lungs, he restored the Dog to Life; and then ceasing blowing, the Dog would soon fall into dying Fits; but by blowing again, he recovered; and so alternately would die, and recover, for a considerable Time, as long, and often as they pleased. Philos.

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For the farther Confirmation of Dr. Thurston's Opinion, the ingenious Dr. Musgrave cut off, and close stopped up the Wind-Pipe of a Dog with a Cork, and then threw open the Thorax; where he found the Blood stagnating in the Lungs, the Arteria Pulmonaris, the Right Ventricle and Auricle of the Heart, and the two great Trunks of the Cava, distended with Blood to an immense Degree; but at the same Time, the Vena Pulmonaris, the Left Ventricle and Auricle of the Heart in a manner empty, hardly a spoonful of Blood therein. Philos. Trans. No. 240. Or both the Experiments may be together

met with in Lowth. Abridg. Vol. 3. p. 66, 67.

This Opinion of our learned Thurston, the late learned Etmullerus espoused, who being Particular in reckoning up the Uses of Respiration, I shall therefore the more largely cite him. Respiration, saith he, serves, 1. Ad Olfactum. 2. Ad Screatum & Sputationem. 3. Ad Oscitationem, Tuffim, Sternutationem, Emunctionemque. 4. Ad liquidorum Sorbitionem, Suctionemve. 5. Ad Lequelam, Cantum, Clamorem, Risum, Fletum, Flatum, Ge. 6. Ad facum Alvi, Urina, Fætûs Molæve, necnon Sesundinarum ex-pulsionem. 7. Ad promovendi Ventriculi, Intestinorum, Latteorumque vasorum, &c. contenta. 8. Ad halitus aqueos Sanguinis è pulmonibus, aeris ope, exportandos. 9. Ad Diapnoen. 10. Ad exactiorem Chyli, Lymphaque, necnon Sanguinis-miscelam. 11. Ad conciliandum sanguini — coccineam rubedinem, &c. 12. Nec morose ne-gabimus, aerem — pulmones, & sanguinem illos transcurrentem, miaus calida reddere, &c. 13. Quod denique aer sanguini singulis Respirationibus aliquantilla sui parte, admixtus, paucissimas quasdam in spirituum animalium elaboratione particulas simul contribuat. All these Uses, although of great Consequence, yet he thinks rather conduce to the Well-being, than the Being of the Animal; because without any of them, the Animal would not fo speedily die, as it doth by Strangling, or in the Air-Pump, He therefore affigns a 14th, and the principal Use of Respiration to be, For the passing of the Blood through the Lungs, that is thrown into them by the Heart. Etmull. Difert, 2, cap. 10, fest. 1, & 16.

But the late Dr. Drake, with great Ingenuity and Address, (like a Person so considerable for his Years, as he was in his Time,) not only established this Notion of Respiration, but also carries it farther, making it the true Cause of the Diastola

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Speech taken as fynonymous Things, or at least, necessary Concomitants of one another. Moses (b) expresseth Animal-Life, by [The Breath of Life.] Saith he, Gen. vii, 21. 22. All Flesh that moveth on the Earth, Fowl, Cattle, Beast, creeping Things,

of the Heart; which neither Borelle, Lower, or Cowper, much less any before those great Men, have well accounted for. That the Heart is a Muscle, is made evident beyond all Doubt by Dr. Lower. And that the Motion of all Muscles confists in Constriction, is not to be doubted also. By which Means the Systole is easily accounted for. But forasmuch as the Heart hath no Antagonist-Muscle, the Diastole hath puzzled the greateft Wits. But Dr. Drake with great Judgment, and much Probability of Reason, maketh the Weight of the Incumbent Atmosphere to be the true Antagonist to all the Muscles, which ferve both for ordinary Inspiration, and the Constriction of the Heart. The Particulars of his Opinion may be feen in his Angtony, 1, 2. c. 7. And in Philof. Trans. No. 281.

And I remember when I was at the University, my most ingenious and learned Tutor Dr. Wills, when he read Anatomy to us, was of Opinion, That the Lungs were blown up by the Weight of the incumbent Air, and represented the Manner of Respiration in this manner, viz. He put a Bladder into a Pair of Bellows, turning back the Neck of the Bladder, and tying it fast, so that no Air might enter in between the Bladder and Bellows. This being done, when the Bellows were opened, the Bladder would be blown up by the Weight of the incumbent Air; and when shut, the Air would be thereby pressed forcibly out of the Bladder, so as to blow the Fire. This Experiment I take Notice of here; because (besides the Illustration it gives to Respiration) that great Genius seems to have had a truer Notion of this Phanomenon, than was very Common then, viz. about the Year 1677, or 78; as also, because I have in some Authors met with the same Experiment, without mention of Dr. Wills, whose I take it to have been.

Another Use of great Consideration, the already commended Dr. Cheyne affigns; namely, to Form the elaftick Globules of which the Blood principally confifts, without which there would be a general Obstruction in all the capillary Arteries. Cheyne's Philosophical Princ, of Natur. Religion; of

Harris's Lex. Tech. in Lungs.

(b) Gen. ii. y .- vi. 17. and vii. 15.

(c) Be-

Things, and Man; all in whose Nostrils was the Breath of Life in the dry Land died. So the Psalmist, Psal. civ. 29. Thou takest away their Breath, they die. So grand an Act therefore in Common to all Animals, may justly deserve a Place in this Survey of the Works of God in the

Animal-Kingdom.

And here I might launch out into an ample Defcription of all the Parts ministring to this necessary Act, and shew the curious Contrivance, and artificial Structure of them; but a transient View shall suffice. I might begin with the outward Guards, the Nose and Mouth; but these have been already touched upon. But the exquisite Mechanism of the Larynx, its Variety of Muscles, its Cartilages, all so exquisitely made for the Purpose of Respiration, and forming the Voice (c), are very admirable: And

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⁽c) Because it would be endless to specify the curious Mechanism of all the Parts, concurring to the Formation of the Voice; I shall therefore for a Sample note only two Things: 1. There are thirteen Muscles provided for the Motion of the five Cartilages of the Larynx. Gibs. Anat. 1. 2. c. 14. a Sign of the careful and elaborate Provision that is made for the Voice. 2. It is a prodigious Faculty of the Glottis, in contracting and dilating it felf with such Exquisiteness, as to Form all Notes. For (as the ingenious Dr. Keil faith,) supposing the greatest Distance of the two Sides of the Glottis, to be one tenth Part of an Inch in sounding twelve Notes. (to which the Voice easily reaches;) this Line must be divided into twelve Parts, each of which gives the Aperture requisite for such a Note, with a certain Strength. But if we consider the Sub-division of Notes, into which the Voice can run, the Motion of the Sides of the Glottis is still vastly nicer. For if two Chords sounding exactly Unisons, one be sportened one two-thousandth Part of its Length, a just Ear will perceive the Disagreement, and a good Voice will found the Difference, which is one one-hundred and ninety-fixth Part of a Note. But suppose the Voice can divide a Note into a hundred Parts, it follows that the different Apertures of the Glottis actually divide the tenth Part of an Inch into twelve-hundred Parts, the

no less so is the Tongue (d), which ministers to

that, and many other Uses too.

Next, the Fabrick of the (e) Trachea deserves especial Remark. Its Valve, the Epiglottis on the Top, to sence against all Annoyances; its cartilagi-

nous

Effect of each of which produces a sensible Alteration upon a good Ear. But because each Side of the Glottis moves sust equally, therefore the Divisions are sust double; or the Sides of the Glottis, by their Motion, do actually divide one-tenth Part of an Inch into two-thousand sour-

bundred Parts. Keil's Anat, cap. 3. fect. 7.

(d) Among the Instruments of Speech, the Tongue is a necessary one; and so necessary, that it is generally thought no Speech can be without it. But in the third Tome of the Epbem. Germ. is Published, Fac. Rolandi Aglossoftomographia, size Descriptio Oris sine Lingua quod perfette loquitur, & reliquas suas functiones naturalizer exercet. The Person described is one Pat, Durand, a French Boy of eight or nine Years old, who at sive or six lost his Tongue by a Gangrene, occasion'd by the Small-Pox: Notwithstanding which, he could (as the Title saith) speak perfectly, as also taste, spit, swallow, and chew his Food; but this Latter he could do only on that Side he put it into, not being able to turn it to the other Side his Mouth.

In the same Tract, Chap. 6. is this Observation of Ventrilo.
guous Persons; Memini me à quodam sat celebri Anatomico audivisse, dum de duplicatura Mediassini ageret, si Membrana ista duplex naturaliter unita in duas partes dividatur, loquelam quasi ex pessore procedere, ut circumstantes credant Damonidcum bunc, aut Sternomythum.

(e) The Variation of the Wind-pipe is observable in every Creature, according as it is necessary for that of the Voice. In an Urchin, which hath a very small Voice, it is hardly more than membranous: And in a Pidgeon, which hath a low and soft Note, it is partly cartilaginous, and partly membranous. In an Owl, which hath a good audible Note, it is more cartilaginous; but that of a Jay, hath hard Bones instead of Cartilages; and so of a Linnet: Whereby they have both of them a louder and stronger Note, &c.

The Rings of the Wind-pipe are fitted for the Modulation of the Voices. For in Dogs and Gats, which in the Expression of divers Passions use a great many Notes, (as Men do.) they are open and flexible, as in Man. Whereby all, or any of them are dilated, or contracted, more or less, as is convenient for a higher or deeper Note, &c. whereas in some other Amimals, as in the Japan-Peacock, which useth hardly more than one single Note, they are entire, &c. Grew's Cosmolog. Sacr. Book I. Chap. 5. Sett. 9, 19.

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nous Rings (f) nearly environing it, with its membranous Part next the Gullet, to give the freer Paffage to the Descent of the Food. And lastly, Its inner Tegument of exquisite Sense to be readily affected with, and to make Efforts against every Thing that is hurtful or offensive; these, I say, do all justly deserve our Admiration.

And no less prodigious are the Parts farther within; the Bronchi, the Vesicula (g), with their mus-

cular

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(f) It is a farther manifest Indication of singular Design in the cartilaginous Rings of the Aspera Arteria, that all the Way where they are contiguous to the Oesophagus, they are membranous, to associate an easy Passage to the Food; but after that, in the Bronchi, they are, some compleatly annular, some triangular, &c. And another observable is, the lower Parts of the superior Cartilages, receive the upper Parts of the inferior in the Bronchi; whereas in the Aspera Arteria, the Cartilages run and remain Parallel to one another; which is a noble Difference or Mechanism in this (in a Manner) one and the same Part, enabling the Lungs, and Bronchi, to contract themselves in Expiration, and to extend and dilate themselves in Inspiration,

(g) Ishall not here intrench so much upon the Anatomist's Province, to give a Description of the Lungs, although it be a curious Piece of God's Workmanship; but refer to Seignior Malpighi, the first Discoverer of their Vesiculae in 1660, in his two Letters to Borelli de Pulmon. Also to Dr. Willis's Pharm, rat. Pag. 2. Sect. 1. Cap. 1. de Respir. Org. & Us. who as he wrote after Malpighi, so hath more accurately described those Parts; and to Mr. Cowper's Anat. Tab. 24, 25. And if the Reader hath a Mind to see what Opposition Seignior Malpighi's Discoveries met with at Home and Abroad, and what Controversies he had on that Account; as also his Censures of Dr. Willis's Description and Figures, he may consult Malpighi's Life written by himself. Pag. 4, to 21.

That the Lungs confift of Vesicula, or Lobuli of Vesicula admitting of Air from the Bronchi, is visible, because they may be blown up, cleansed of Blood, and so dried. But Mr. Cowper saith, he could never part the Lobuli, (so as to make Dr. Willis's Fig. 1. Tab. 3, & 4.) so that probably the Vesicula are contiguous to one another throughout each Lobe of the Lungs.

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cular Fibres (b), as some affert they have, together with the Arteries and Veins, which every where accompany the airy Passages, for the Blood to receive there its Impregnations from the Air.

From hence I might proceed to the commodious Form of the Ribs (i), the curious Mechanism of

And not only Air; but Diemerbroeck proves, That the Vesicula admit of Dust also, from two Ashmatick Persons he opened; one a Stone-cutter's Man, the Vesicula of whose Lungs were so stuffed with Dust, that in cutting, his Knife went as if through an Heap of Sand; the other was a Feather-driver, who had these Bladders filled with the fine Dust or Down of

Feathers.

(b) There is a confiderable Difference between Dr. Willing and Etmuller, viz. Whether the Vesicula of the Lungs have any mulcular Fibres, or not? Etmuller expresly faith, Nullas Fibras musculosas, multo minus rubicundam Musculorum compagem (sunt enim Vesicula albida & fere diaphana) in ipsis reperiri. Ubi supra. cap. 6. fect. 2. And afterwards, fect. 3. Pulmones effe molles flexilesque musculosis fibris ceu propriæ explicationis organis destitutes, But Dr. Willis as expresly afferts, they have musculous Fibres, and affigns an excellent Use of them; Cellule ifte vefice. lares, ut nixus pro expiratione contractivos edant, etiam fibras, ui per Microscopium plane conspicere est, musculares obtinent. Ubi fupra, fect. 16. And in the next Section, Ut pro data occasione majorem aeris copiam exsufflent, aut materiam extussiendam ejiciant, fibris muscularibus donata, sese arctius contrabunt, contentaque sua penitus exterminant. Et enim ordinaria pectoris Systola, quas musculorum relarationes ex parte efficient, aerem forsan totum à Trached & Bronchiis, band tamen à Vesiculis, quaque vice ejiciunt: propter has (quoties opus erit) inaniendas. & totius Pectoris cavitas plurimum angustatur, & cellula ipsa vesiculures à propriis fibris constrictis coaretantur.

(i) Circa hos motus [Scil. Pectoris dilatationem, &c.] divini Conditoris mechanicen, ad regulas Mathematicas plane adaptam, satis admiran non possumus ; siquidem nulla alia in re manifestius O Out yeauelpeir videtur. Quippe cum pectoris, tum ampliatio, tum coardstio à quibusdam Musculis (quorum munus unicum est contrahere) perfici debeat; res ita instituitur, ut Costa qua theracis, velut parallelegrammi oblongi versus cylindrum incurvati, latera efformant, in figuram modò quadratam, cum angulis redis, pro pectoris ampliatione; mode il rhomboeidem, cum angulis acutis pro ejusaem contentione, ducantur, &

Willis, ubi fupra, feet. 28.

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ect. 6.

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the Intercostal-Muscles (k), the Diaphragm, and all the other Muscles (l) ministring both to the ordinary, and extraordinary Offices of Respiration.

But

Galen having spoken of the Parts ministring to Respiration, concludeth, Nibil usquam à Natura ullo pasto per incuriam, suisse prateritum, qua cum omnia prasentiret & provideret, qua sunt necessaria illa, qua causa alicujus extiterunt, consecutura, omnibus instaurationes parare occupavit, cujus apparatus copiosa facultas admirabilem Sapientiam testantur. De Us. Part. 1.5. c. 15. See also 1.6. c. 1.

(k) For the Structure of the Intercostals, Midriff, &c. I shall refer to Dr. Willis, and other Anatomists. But Dr. Drake taxeth Dr. Willis with an Error, in fancying there is an Opposition in the Ossicc of the Intercostals, by Reason that the Fibres of the external and internal Intercostals decussate; that therefore the external serve to raise the Ribs, the internal to draw them lown. But Dr. Drake is of Steno's, and Dr. Mayow's Opinion. That notwithstanding the Decussation of their Fibres, the Power they exert upon, and the Motion they effect in the Ribs, is one and the same. Drake's Anat. 1. 2. c. 7. and 1. 4.

5. Mayow de Respir. c. 7.

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(1) Although Dr. Drake, and some others, deny the Interpostals being Antagonist-Muscles, as in the preceding Note; ret they, and most other Anatomists that I have met with tribute a considerable Power to them in the Act of Respiration, as they do also to the Subclavian and Triangular-Muscles; but the learned Etmuller denies it for these three Reasons, I. Quia respirando nullam in illis contractionem sentio. 2. Quia—sibi invicem non adducuntur, &c. 3. Quia Costa omnes ab aliis nodo enarratis musculis moventur, idque simul, &c. Intercostales itaue, necnon Subclavios Musculos Costis, parietum instar, ad complenda nerstitia intercostalia, pectusque integrandum, ac Costas connectendas, nertectos esse, probabiliter concludo; quo munere triangulares etiam—fungi, rationi consentaneum est. Etmul. Dissert. 2. cap. 4. ect. 6.

But as to the Use of the Triangular-Muscle in Respiration, ve may judge of it, from its remarkable Size and Use in a log; of which Dr. Willis gives this Account from Fallopius: "Homine parous aded & subtilis iste [Musculus] est, ut vix produsculo accipi queat: in Cane per totum os pectoris protenditur, & vitilagines omnes, etiam verarum Costarum sterno inosculatas, occunt: Cujus discriminis ratio divinam circa Animalium fabricas Provintiam plane indigitat. Quippe cum koc animal, ad cursus velocission & diu continuandos natum, quo sanguis, dum intensius agitatur.

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But passing them by, I shall stop at one prodigious Work of Nature, and manifest Contrivance of the Almighty Creator, which although taken Notice of by others (m), yet cannot be easily passed by in the Subject I am upon; and that is the Circulation of the Blood in the Fatus in the Womb, so different from the Method thereof after it is Born. In the Womb, whilst it is as one Body with the Mother, and there is no Occasion, nor Place for Respiration, there are two Passages (n) on Purpose for the Transmission of the Blood without passing it through the Lungs.

rità accendatur eventileturque, aerem celerrime & fortiter uti inspirantita etiam exspirare debet—ideireo propter hunc actum sirmiùs obemedum (cujus in Homine haud magnes est usus) musculus caninus melen ingentem & tanto operi parem sortitur. Willis, ubi supra, sect. 32.

ingentem & tanto operi parem fortitur. Willis, ubi supra, sect. (m) Ray's Wisdom of God in the Creation. Pag. 343.

(n) Mr. Chefelden, an ingenious and most accurate Anatomist, having somewhat Particular in his Observations about the Circulation of the Blood through the Heart of the Fatur, I shall present the Reader with some of his Observations, which he favoured me with the Sight of. The Blood (faith he) which is brought to the Heart by the ascending Cava, passes out of the Right Auricle into the Left, through a Passage called Foramen Ovale, in the Sceptum [common to them both] without page fing through the Right Ventricle (as after the Birth) while the Bloodfrom the descending Cava passeth through the Right Auricle and Ventrul into the Pulmonary Artery, and thence into the Aorta through the Dut, betwixt that and the Pulmonary Artery, called Ductus Arteriolis, whilst a small Portion of the Blood, thrown into the Pulmonary Anton passeth through the Lungs, no more than is sufficient to keep open the Pulmonary Veffels. Thus both Ventricles are employed in driving the Blood through the Aorta to all Parts of the Foctus, and to the Mount toc. But after the Birth, the Blood being to be driven from the Aorti through the Fætus alone, and not the Mother too, one Ventricle becomes Sufficient, whilst the other is employed in driving the Blood through the Lungs, the Ductus Arteriosus being sout up by means of the Alters tion of its Position, which happens to it from the raising the Aorta bbe Lungs, when they become inflated. After that the Blood is that driven into the Lungs, in its return it souts the Valve of the Foramen Ovale against the Foramen it felf, to whose Sides it soon adheres, and for nea me ous thei

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CHAP. VII. Of Respiration,

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Lungs. But as soon as the Fatus is Born, and become thereby a perfectly distinct Being, and breathes for it self, then these two Passages are shut up; one nearly obliterated, the other becomes only a Ligament, except in some Creatures that are Amphibious, or are forced to lie long under Water, in whom these Passages probably remain open (0).

And now what Action of any rational Creature, what is there in a Man's Life, that doth more

plainly

fo ftops up the Passage. The Ductus Arteriosus, or Ductus Arteriosus in Ligamentum versus, is seldom to be discerned in adult Bodies, but the Figure of the Foramen Ovale is never obliterated.

(0) It hath been generally thought to be not improbable, but that on some Occasions the Foramen Ovale may remain open in Man. In a Girl of four or five Years of Age, Dr. Connor found it but half closed, and in the Form of a Crescent. And he thinks somewhat of this Kind might be in the Person whose Skeleton was found to have no Joints in the Back-Bone, Ribs, &c. Of which a Description, with Cuts, may be found in Phil. Trans. No. 215. And more largely in his Dissert. Med. Phys. de stupendo Ossicum coalitu, where he adds to the Girl, in whom the For. Ov. was not shut, a like Observation of another Girl he opened at Oxford of three Years Old ; In qua Foramen Ovale ferè erat occlusum, in medio tamen, exili foramine, per quod Turundam facile transmisi, erat pervium, p. 30. So Mr. Cowper (than whom none more accurate and a better Judge) faith, I have often found the Foramen Ovale open in the Adult. Anat. Append. Fig. 3. But Mr. Chefelden is of a diffe-Of which in the following Note. rent Opinion.

From somewhat of this Cause, I am apt to think it was that the Tronningholm Gardiner escaped drowning, and some others mentioned by Pechlin. His Stories are, Hortulanus Tronningholmensis etiamnum vivens, annos natus 65, pro illa atate satis adhuc valens & vegetus, cùm ante 18 annos, alii in aquas delapso opem ferre vellet, forte sortuna & ipse per glaciem incautiùs procedens, aquas incidit 18 ulnas profundas: ubi ille, corpore eretto quasi ad perpendiculum, pedibus sundo adhasit. Constitit sic per 16 horas, antequàm produceretur in auras. Dixit autem, simul ac infra aquarum superficiem suit demersus, statim obriguisse totum, &, si quem tum babuit motum & sossum, amissife, nisi quod sonantes Stockolmii campanas etiam sub aquis obscuriùs percipere sibi sit visus. Sensit etiam, statim sese velut

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plainly shew Design, Reason, and Contrivance, than this very Act of Nature doth the Contrivance

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vesiculam ori applicasse, adeò ut aqua nulla os penetraverit, in auni verd transitum, etiam sentiente illo, habuerit ; atque inde auditum suum dehilitatum aliquandiu effe. Hoc ftatu dum 16 horas permanfit fru. ftrà quafitus, tandem repertum, conto in caput infixe, cujus etiam fen. sum se habuisse dixit, fundo extraxerunt, sperantes ex more aut persua. fione gentis revicturum effe. Itaque pannis linteifque productum obvol. munt, ne aere admitti possit perniciosus futurus subito illapsu: custodi. tum fie fatis ab aere fensim sensimque tepidiori loco admovent mox calidis adoriunter fasciis, fricant, radant, & Sufflaminatum tet boris sanguing corporisque motum negotiosa illa opera reducunt : denique antapopletticis & genialibus liquoribus vita reddunt & pristina mobilitati. Retulit is atque oftendit se etiamnum in capite circumferre vestigia violentia à conto illata. & cephalalgiis vexari gravissimis. Et propter hunc ipsum casum religiose à popularibus. & hujusce rei testibus probatum, Serenis. sima Regina matris munificentia & annuo stipendio est donatus-8 Serenif. Principi -- oblatus vivus sui testis -- Consignatam manu habes Historiam D. Tilasii, Biblioth, Reg. Prafecti, qui testatus est se pranovisse mulierem, que tres ipsos dies sub aquis hasit. & similem in modum, quo Hortulanus ille, resuscitata, adhuc dum lucis plent fruitur usura. Accedit Nob. Burmanni ___fides, qui confessus est, __sein pago Boness parochia Pithoviæ concionem frequentasse funebrem, in qua, dum acta recenseret Praco Senis cujusdam septuagenarii Laur. Jonæ -audiverit ex ore Concionatoris, vivum eum, adolescentem 17 annorum, aquis submersum, 7 demum hebdomada (rem prodigiosam!) extractum ad se rediffe vivum & incolumen. Pechlin, de Aer, & Alim, def. c. 10.

Shall we to this Cause, or to the Ossisication, or more than ordinary Strength of the Wind-Pipe, attribute the Recovery to Life of Persons hanged? Of which Pechlin gives an Instance that fell under his own Knowledge, of a Woman hanged, and in all Appearance dead, but recovered by a Physician accidentally coming in, with a plentiful Administration of Spir. Sal. Armon. Pechl. ib. c. 7. And the Story of Anne Green, executed at Oxford, Dec. 14, 1650. is still well remembered among the Seniors there. She was hanged by the Neck near half an Hour, some of her Friends in the mean Time thumping her on the Breast, others hanging with all their Weight upon her Legs, sometime lifting her up, and then pulling her down again with a sudden Jink, thereby the sooner to dispatch her out of her Pain; as her printed Account wordeth it. After she was in her Cossin, being observed to breathe, a lusty Fellow stamped with a shis Force

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CHAP. VII. Of Respiration. 1

and Design of the great God of Nature? What is Thought and Contrivance, if this be not? Namely, That there should be a temporary Part in the Body, made just for the present Exigence; to continue whilst there is Occasion for it, and to cease when there is none; in some Creatures to remain always, by Reason of their amphibious Way of Living, and

in Land-Animals (purely fuch) to cease.

Another excellent Contrivance, a-kin to the last, is, for the Preservation of such Creatures whose Occasions frequently necessitate them to live without, or with but little Respiration: Fishes might be named here, whose Habitation is always in the Waters; but these belong to an Element which I tannot at present engage in. But there are many Animals of our own Element, or partly so, whose Organs of Respiration, whose Blood, whose Heart, and other Instruments of Life, are admirably accommodated to their Method of Living: Thus many amphibious Creatures (p), who live in Water

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(p) The Sea-Calf hath the Foramen Ovale, by which Means it senabled to stay long under the Water, as the Parif. Ana-

omists. Of which see in Book VI. Chap. 5. Note (c).

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n her Breast and Stomach, to put her out of her Pain. But by the Assistance of Dr. Peity, Dr. Willis, Dr. Bathurst, and Dr. Clark, she was again brought to Life. I my self saw her many Years after, after that she had (I heard) born divers Children. The Particulars of her Crime, Execution and Restauration, see in a little Pamphlet, called News from the Dead, written, as I have been informed, by Dr. Bathurst, afterwards the most vigilant and learned President of Tritity-College, Oxon,) and published in 1651, with Verses upon the Occasion.

But the fore-commended Mr. Chefelden, thinks the Foramen Puale is neither open in amphibious Creatures, nor any adult Land-Animals. When I first (faith he) applied my self to the Difettion of Human Bodies, I had no distrust of the frequent Accounts of

as well as Air; many Quadrupeds, Birds, Insects, and other Animals, who can live some Hours, Days, yea, whole Winters, with little or no Respiration, in a Torpitude, or sort of Sleep, or middle State between Life and Death: The Provision made for these peculiar Occasions of Life, in the Fabrick of the Lungs, the Heart, and other Parts of such Creatures (q), is manifestly the Work of Him, who as St. Paul saith (r), Giveth to all Breath, and Life, and all Things.

the Foramen Ovale being open in Adults; but I find since, that I mission the Ostium Venarum Coronariarum for the Foramen. The like I suppose Authors have done, who affert that it is always open in amphibious Animals; for we have made diligent Enquiry into those Animals, and never found it open. Neither would that (as they imagine) serve these Creatures to live under Water, as the Foctus dolb in Utero, unless the Ductus Arteriosus was open also.

This Opinion of Mr. Chefelden hath this to render it probable, That the Offium Venarum Coronariarum is so near the Foramen Ovale, that without due Regard, it may be easily mistaken for it. Such therefore as have Opportunity of examining this Part in amphibious Animals, or any other Subject, ought to seek for the Offium, whenever they suspect

they have met with the Foramen.

(q) Of the fingular Conformation of the Heart and Lung of the Tortoise, which is an Amphibious Animal. See Book VI. Chap. 3. Note (b).

(r) Atts xvii. 25.

HEEREPREERSERFERERES EERERRR

CHAP. VIII. Of the Motion of Animals.

NEXT to the two Grand Acts of Animal Life, their Sense or Respiration, I shall consider their Motion, or Locomotive Faculty; whereby they convey themselves from Place to Place, according to their Occasions, and Way of Life: And the admirable Apparatus to this Purpose, is a plain Demonstrated to the purpose of the purpose.

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Demonstration of God's particular Foresight, Care, and especial Providence towards all the Animal World.

And here I might View, in the first Place, the Muscles, their curious Structure (a), the nice tacking them to every Joint, to pull it this Way, and that Way, and the other Way, according to the special Purpose, Design, and Office of every such Joint: Also their various Size and Strength; some large and corpulent, others less, and some scarce visible to the naked Eye; all exactly sitted to every Place, and every Use of the Body. And lastly, I might take Notice of the muscular Motions, both involuntary and spontaneous (b).

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⁽a) That the Muscles are compounded of Fibres, is visible enough. Which Fibres, the curious and ingenious Borelli saith, are cylindraceous; not hollow, but filled with a spungy, pithy Substance, after the Manner of Elder, as he discovered by his Microscopes. Borel, de Mot. Animal, Part 1.

These Fibres, he saith, are naturally white; but derive their Redness only from the Blood in them.

These Fibres do in every Muscle, (in the Belly at least of the Muscle,) run Parallel to one another, in a neat orderly Form. But they do not at all tend the same Way, but some run aslant, some long-ways, &c. according to the Action or Position of each respective Muscle. The Particulars of which, and of divers other Observables in the Muscles, would, besides Figures, take up too much Room in these Notes; and therefore I must refer to the Anatomists, particularly Steno, Borelli, Comper, &c.

⁽b) The Infinite Creator hath generally exerted his Art and Care, in the Provision made by proper Muscles and Nerves, for all the different Motions in Animal Bodies, both involuntary, and voluntary. It is a noble Providence, that most of the vital Motions, such as of the Heart, Stomach, Guts, &c. are involuntary, the Muscles acting whether we sleep or wake, whether we will, or no. And it is no less Providential that some, even of the vital Motions, are partly voluntary, partly involuntary, as that for Instance, of Breath-

Next, I might Survey the special Fabrick of the Bones (c), ministring to Animal Motion. Next, I might

ing, which is performed both sleeping and waking; but can be intermitted for a short Time on Occasion, as for accurate Hearing any Thing, &c. or can be encreased by a stronger Blast, to make the greater Discharges of the Blood from the Lungs, when that any Thing overcharges them. And as for the other Motions of the Body, as of the Limbs, and such as are voluntary, it is a no less Providence, that they are absolutely under the Power of the Will; so as that the Animal hath it in his Power to command the Muscles and Spirits, or any Part of its Body, to perform such Motions and Actions as it hath Occasion for.

(c) Quid dicam de Ossibus? qua subjetta corpori mirabiles commissuras habent, & ad stabilitatem aptas, & ad artus finiendos accommodatas, & ad motum, & ad omnem corporis attionem. Cicer. de Nat.

Deor. 1. 2. c. 55.

By Reason it would be endless to mention all the Curiosties observable in the Bones, I shall for a Sample, single out only an Instance or two, to manifest that Design was used in

the Structure of these Parts in Man.

The first shall be in the Back-Bone, which (among many others) hath these two Things remarkable. 1. Its different Articulations from the other Joints of the Body. For here most of the Joints are flat, and withal guarded with Asperities and Hollows, made for catching and holding; so as firmly to lock and keep the Joints from Luxations, but withal to afford them such a Motion, as is necessary for the Incurvations of the Body. 2. The difference of its own Joints in the Neck, Back and Loins. In the Neck, the Atlas, or upper Vertebra, as also the Dentata, are curiously made, and jointed (differently from the rest) for the commodious and eafy bending and turning the Head every Way. In the Thorax, or Back, the Joints are more close and firm; and in the Loins, more lax and pliant; as also the Spines are different, and the Knobs and Sockets turned the quite contrary Way, to answer the Occasions the Body hath to bend more there, than higher in the Back. I shall close this Remark with the ingenious Dr. Keil's Observation.

The Structure of the Spine is the very best that can be contrived; for had it been all Bone, we could have had no Motion in our Backs; had it been of two or three Bones articulated for Motion, the Medulla Spinalis must have been necessarily bruised at every Angle or Joint; besides,

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besides, the whole would not have been so pliable for the several Postures we have Occasion to put our selves in. If it had been made of several Bones without intervening Cartilages, we sould have had no more Use of it, than if it had been but one Bone. If each Vertebra had had its own distinct Cartilages, it might have been easily dislocated. And lastly, The oblique Processes of each superior and inserior Vertebra, keep the middle one that it can neither be thrust backwards nor sorwards to compress the Medulla Spinalis. Keil's Anat. cap. 5. sect. 8,

Compare here what Galen faith of the Articulations, Ligaments, Perforation, &c. of the Spine, to prove the Wisdom and Providence of the Maker of Animal Bodies, against such as found Fault with Nature's Works; among which he names Diagoras, Anaxagoras, Asclepiades and Epicurus. Vid. Galen. de Us.

Part. 1. 12. init. and Chap. 11, &c. alfo L. 13. init.

2. The next Instance shall be in one or two Things, wherein the Skeletons of Sexes differ. Thus the Pelvis made in
the Belly by the Ilium, Ossa Covendicis and Pubis, is larger in a
Female than Male Skeleton, that there may be more Room
for the lying of the Viscera and Fætus. So the Cartilage bracing together the two Ossa Pubis, or Sharebones, Bartboline saith,
is twice thicker and laxer in Women than Men: As also is
the Cartilage that tieth the Os Sacrum to its Vertebra; and all
to give Way to the Passage of the Fætus.

Another confiderable Difference is in the cartilaginous Production of the seven long Ribs, whereby they are braced to the Breast-Bone. These are harder and sirmer in Women than in Men; the better to support the Weight of the

Breafts, the fucking Infant, &c.

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(d) It is remarkable in the Joints, and a manifest Act of Caution and Design: 1. That altho' the Motion of the Limbs be circular, yet the Center of that Motion is not in a Point, but an ample Superficies. In a Point, the Bones would wear and penetrate one another; the Joints would be exceedingly weak, &c. but the Joints confisting of two large Superficies, Concave, and Convex, some surrowed and ridged, some like a Ball and Socket, and all lubricated with an oily Substance, they are incomparably prepared both for Motion and Strength.

2. That the Bones next the Joint are not spungy, as their Extremities commonly are, nor hard and brittle, but capped with a strong, tough, smooth, cartilaginous Substance, serving both to Strength and Motion.

But let us here take Notice of what Galen mentions on this Subject. Articulorum unusquisque Eminentiam Cavitati immissam habet: Veruntamen hoc fortasse non aded mirabile est: Sed se, considerata omnium totius corporis ossum mutud connexione, Eminentias cavitatibus suscipientibus aquales semper inveneris 3 Hoc mirabile. Si

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might take Notice of the Joints (d), their compleat Form adjusted to the Place, and Office they are employed in; their Bandage, keeping them from Luxations; the oily Matter (e) to lubricate them, and their own Smoothness to facilitate their Motion.

And lastly, I might trace the various Nerves throughout the Body, sent about to minister to its various Motions (f). I might consider their Origin (g),

enim justo amplior esset Cavitas, laxus sane & insirmus sieret Articulus; si strictior, motus dissiculter sieret, ut qui nullam versionem haberet; ac periculum esset non parvum, eminentias ossium artatas frangi: sed horum neutrum factum est. — Sed quoniam ex tam secura constructione periculum erat, ne motiones difficilius sierent. & eminentia ossium extererentur, duplex rursus auxilium in id Natura molita est. I. Cartilagine os utrumque subungens, atque oblinens: alterum, ipsis Cartilaginibus humorem unctuosum, velut oleum, superfundens; per quem facile mobilis, & attritu contumax omnis articulatio Ossium facta est. — Ut undique diligenter Articulus omnis custodiretur, Ligamenta quedam ex utroque osse produxit Natura. Galen de Us. Part. 1. I. C. 15.

(e) For the affording this oily or mucilaginous Matter, there are Glandules very commodiously placed near the Joints, so as not to suffer too great Compression by the Motion of the neighbouring Bones, and yet to receive a due Pressure, so as to cause a sufficient Emission of the Mucilage into the Joints. Also, another Thing considerable is, that the excretory Ducts of the Mucilaginous Glands have some Length in their Passage from the Glands to their Mouths; which is a good Contrivance, to prevent their Mouths being oppressed by the Mucilage, as also to hinder the too plentiful Essusion thereof, but yet to afford a due Expressure of it at all Times, and on all Occasions, as particularly in violent and long continued Motions of the Joints, when there is a greater than ordinary Expence of it. See Couper's Anat. Tab. 79.

(f) There is no Doubt to be made, but that the Muscles receive their Motion from the Nerves. For if a Nerve be out, or streightly bound, that goes to any Muscle, that Muscle shall immediately lose its Motion. Which is doubtless the Case of Paralyticks; whose Nerves are some of them by Obstructions, or such like Means, reduced to the same State as if out or bound.

And

gin (g), their Ramifications to the feveral Parts. and their Inosculations with one another, according to the Harmony and Accord of one Part with another, necessary for the Benefit of the Animal. But some of those Things I have given some Touches upon already, and more I shall mention hereafter (b), and it would be tedious here to infift upon them all.

Ishall therefore only speak distinctly to the Locomotive Act it felf, or what directly relates to it.

And here it is admirable to confider the various Methods of Nature (i), fuited to the Occasions of

And this also is the Cause of that Numness or Sleepiness we find oftentimes, by long fitting or lying on any Part.

Neither is this a modern Notion only; for Galen faith, Principium Nervorum omnium Cerebrum est, & spinalis Medulla. — Nervi à Cerebro animalem virtutem accipiunt - Nervorum utilitas est facultatem Sensûs & Motis à principio in partes diducere. And this he intimates to have been the Opinion of Hippocrates and Plato, de Uf. Part. 1. 1. c. 16. & passim.

(g) Dr. Willis thinks, That in the Brain the Spirits are elaborated that minister to voluntary Motion; but in the Cerebellum, such as effect involuntary, or natural Motions; such as that of the Heart, the Lungs, &c. Cerebri Anat. c. 15.

(b) See Book V. Chap. 8.

(i) To the foregoing, Ishall briefly add some Examples of the special Provision made for the Motion of some Animals by Temporary Parts. Frogs and Toads, in their Tadpole-state, have Tails, which fall off when their Legs are grown out. The Lacerta Aquatica, or Water-Newt, when Young, hath four neat ramified Fins, two on a Side, growing out a little above its Fore-legs, to poife and keep its Body upright, (which gives it the Resemblance of a young Fish,) which fall off when the Legs are grown. And the Nympha and Aurelia, of all or most of the Infects bred in the Waters, as they have particular Forms, different from the Infects they produce; so have also peculiar Parts afforded them for their Motion in the Waters: Oars, Tails, and every Part adapted to the Waters, which are utterly varied in the Infects themselves, in their mature State in the Air.

(i) Fam

various Animals. In some their Motion is swift, in others flow. In some performed with two, four, or more Legs; in some with two, or four Wings; in

fome with neither (k).

And first for swift or slow Motions. This we find is proportional to the Occasions of each respective Animal. Reptiles, whose Food, Habitation, and Nests, lie in the next Clod, Plant, Tree, or Hole, or can bear long Hunger and Hardship, they need neither Legs nor Wings for their Transportation; but their vermicular or finuous Motion (performed with no less Art, and as curiously provided for as the Legs or Wings of other Creatures: This, I fay,) is sufficient for their Conveyance.

Man and Beafts, whose Occasions require a large Room, have accordingly a swifter Motion, with proper Engines for that Service; answerable to their Range for Food, their Occupation of Business, or their want of Armature, and to secure them against Harms (1). But

(k) Jam verò alia animalia gradiendo, alia serpendo, ad pastum accedunt, alia volando, alia nando. Cic. de Nat. Deor. 1. 2. c. 47.

Compare also what Galen excellently observes concerning the Number of Feet in Man, and in other Animals; and the wife Provision thereby made for the Use and Benefit of the respective Animals. De Us. Part. in the Beginning of the third Book.

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⁽¹⁾ As I shall hereafter shew, That the Indulgent Creator hath abundantly provided for the Safety of Animals by their Cloathing, Habitations, Sagacity and Instruments of Defence; so there appears to be a Contemperament of their Motion with these Provisions. They that are well armed and guarded, have commonly a flower Motion; whereas they that are destitute thereof, are swifter. So also timid helpless Animals are commonly fwift; thus Deer and Hares: But Animals endowed with Courage, Craft, Arms, &c. commonly have a flower Motion,

But for the winged Creatures (Birds and Infects,) as they are to traverse large Tracts of Land and Water, for their Food, for their commodious Habitation, or Breeding their Young, to find Places of Retreat and Security from Mischiefs; so they have accordingly the Faculty of flying in the Air; and that swiftly or flowly, a long or short a Time, according to their Occasions and Way of Life. And accordingly their Wings, and whole Body, are curiously prepared for such a Motion; as I intend to

shew in a proper Place (m).

Another remarkable Thing in the motive Faculty of all Creatures, is the neat, geometrical Performance of it. The most accurate Mathematician, the most skilful in mechanick Motions, cannot prescribe a nicer Motion (than what they perform) to the Legs and Wings of those that walk or fly (n), or to the Bodies of those that creep (0). Neither can the Body be more compleatly poised for the Motion it is to have in every Creature, than it already actually is. From the largest Elephant to the smalleft Mite, we find the Body artfully balanced (p). The Head not too heavy, nor too light for the rest of the Body, nor the rest of the Body for it (q).

(m) See Book VII. Chap. 1.

⁽n) See Book VII. Chap. 1. the End.

⁽⁰⁾ See Book IX. Chap. 1. Note (6).

⁽p) Siquis unquam alius Opifex, equalitatis & proportionis magnam habuit providentiam, certe Natura habuit in animalium corporibus conformandis; unde Hippocrates eam restissime justam nominat. Galen. de Uf. Part. l. 2. c. 16.

⁽⁹⁾ The Make of the Bodies of some Water-Fowl, seems to contradict what I here fay, the Heads and long Necks of some, as of Swans, Ducks and Geese; and the hinder Parts of others, as of the Doucker and Moor-hen, and some other

The Viscera are not let loose, or so placed, as to swag, over-balance, or over-set the Body; but well-braced, and distributed to maintain the æquipoise of the Body. The motive Parts also are admirably well fixed in respect to the Center of Gravity; placed in the very Point, sittest to support and convey the Body. Every Leg beareth his true Share of the Body's Weight. And the Wings so nicely are set to the Center of Gravity, as even in that sluid Medium, the Air, the Body is as truly balanced, as we could have balanced it with the nicest Scales.

But among all Creatures, none more elegant than the fizing the Body of Man, the gauging his Body fo nicely, as to be able to stand erect, to stoop, to fit, and indeed to move any way, only with the Help of so small a Stay as the Feet (r): whose Mechanism of Bones, Tendons and Muscles to this Purpose, is very curious and admirable.

Kinds, feeming to be too heavy for the rest of their Body. But instead of being an Argument against, it is a notable Instance of the Divine Art and Providence, these Things being nice Accommodations to their way of Life. Of such as have long Necks, see Book VII. Chap. 2. Note (i).

And as for such whose hinder Parts seem to over-balance their foremost Parts, whereby they sly with their Bodies in a manner erect, this also is an excellent Accommodation to their way of Life, which is Diving rather than Flying. Vid. Book VII. Chap. 4. Note (k).

(r) See Book V. Chap. 2. Note (b).



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CHAP. IX.

Of the Place allotted to the several Tribes of ANIMALS.

HAving dispatched the Motion of Animals, let us in the next Place confider the Place which the Infinitely Wife Creator hath appointed them to move and act, and perform the Offices of the Creation in. And here we find every Particular well ordered. All Parts of our Terraqueous Globe fit for an Animal to live and act in, are fufficiently flocked with proper Inhabitants: The watery Element (unfit, one would think, for Respiration and Life) abounding with Creatures fitted for it; its Bowels abundantly stored, and its Surface well bespread. The Earth also is plentifully stocked in all its Parts, where Animals can be of any Use; not probably the deepest Bowels thereof indeed, being Parts in all likelihood unfit for Habitation and Action, and where a living Creature would be useless in the World; but the Surface every where abundantly stored.

But that which is most considerable in this Matter, and plainly sheweth the Divine Management in the Case, is, that those Creatures are manifestly designed for the Place in which they are, and the Use and Services they perform therein. If all the Animals of our Globe had been made by Chance, or placed by Chance, or without the Divine Providence, their Organs would have been otherwise than they are, and their Place and Residence con-

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⁽a) Eft etiam admiratio nonnulla in beftits aquatilibus iis, qua gignuntur in terra: veluti Crocodili, fluviatilesque Testudines, quadamque Serpentes orta extra aquam, simul ac primum niti possunt, aquam persequentur. Quin etiam Anatam ova Gallinis Sape Supponimus [Pulli]

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and those on the dry Land Surface, and the Subterraneous under it, they all live and act with Pleasure, they are gay, and flourish in their proper Element and allotted Place, they want neither for Food, Cloathing, or Retreat; which would dwindle and die, destroy, or poison one another, if all coveted the same Element, Place, or Food.

Nay, and as the Matter is admirably well ordered, yet considering the World's Increase, there would not be sufficient Room, Food, and other Necessaries for all the living Creatures, without another grand Act of the Divine Wisdom and Providence, which is the Balancing the Number of Individuals of each Species of Creatures, in that Place appointed

thereto: Of which in the next Chapter.

[Pulli] deinde eas [matres] relinquunt——& effugiunt, cum prinum aquam, quasi naturalem domum, videre potuerunt Cic. de Nat. Deor. l. 2. c. 48.

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CHAP. X.

Of the Balance of Animals, or the due Proportion in which the World is stocked with them.

THE whole Surface of our Globe can afford Room and Support only to such a Number of all Sorts of Creatures. And if by their doubling, rebling, or any other Multiplication of their Kind, they should encrease to double or treble that Number, they must starve, or devour one another. The keeping therefore the Balance even, is manifestly a Work of the Divine Wisdom and Providence. To which End, the great Author of Life hath determined

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BOOK IV. termined the Life of all Creatures to fuch a Length. and their Increase to such a Number, proportional to their Use in the World. The Life of some Creatures is long, and their Increase but small, and by that Means they do not over-stock the World And the same Benefit is effected, where the Increase is great, by the Brevity of fuch Creatures Lives, by their great Use, and the frequent Occasions there are of them for Food to Man, or other Animals, It is a very remarkable Act of the Divine Providence, that useful Creatures are produced in great Plenty (a), and others in less. The prodigious and frequent Increase of Insects, both in and out of the Waters, may exemplify the one; and 'tis obfervable in the other, that Creatures less useful, or by their Voracity pernicious, have commonly fewer Young, or do feldomer bring forth: Of which many Instances might be given in the voracious Beasts and Birds. But there is one so peculiar an Animal, as if made for a particular Instance in our present Case, and that is the Cuntur of Peru(b): A Fowl of that Magnitude, Strength and Appetite, as to feize not only on the Sheep, and leffer Cattle, but

(a) Benigna circa hoc Natura, innocua & esculenta animalia fa-

cunda generavit. Plin. Nat. Hist. 1. 8. c. 55.
(b) Captain J. Strong, gave me this Account, together with a Quillette. Feather of the Cuntur [or Condor] of Peru. On the Coast of Chill, they met with this Bird in about 33° S. Lat. not far from Mocha, at Island in the South-Sea, -they shot it sitting on a Cliff, by the Sea-Ede ; that it was 16 Feet from Wing to Wing extended ; that it Spanish Inhabitants told them they were afraid of these Birds, if they bould prey upon their Children. And the Feather he gave me (faith the Doctor) is 2 Feet 4 Inches long; the Quill-part 5 Inches that quarters long, and I Inch and half about in the largest Part. eweighed 3 dr. 17 er. and half, and is of a dark-brown Colour. Dt. Sloane in Philof. Tranf. No. 208. To

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even the larger Beasts, yea, the very Children too. Now these, as they are the most pernicious of Birds, so are they the most rare, being seldom seen, or only one, or a few in large Countries; enough to keep up the Species; but not to over-charge the World.

Thus the Balance of the Animal World, is, throughout all Ages, kept even; and by a curious Harmony, and just Proportion between the Increase of all Animals, and the Length of their Lives, the World is through all Ages well, but not over-stored: One Generation passeth away, and another Generation cometh (c); so equally in its Room, to Balance the Stock of the Terraqueous Globe in all Ages, and Places, and among all Creatures; that it is an actual Demonstration of our Saviour's Assertion, Mat. x. 29. that the most inconfiderable.

To this Account, the Doctor, (in a Letter to Mr. Ray, March 31, 1694, with other Papers of Mr. Rays, in my Hands.) adds the Testimony of Fos. Acosta, 1. 4. c. 7. and Garcilass. de la Vaga, who l. 8. c. 19. faith, There are other Fowls, call'd Cuntur, and by the Spaniards corruptly Condor. Many of these Fowls having been kill'd by the Spaniards, had their Proportion taken, and from End to End of their Wings measured 15 or 16 Feet. ____ Nature, to . temper and allay their Fierceness, deny'd them the Talons which are given to the Eagle; their Feet being tipp'd with Claws like a Hen: However, their Beak is strong enough to tear off the Hide, and rip up the Bowels of an Ox. Two of them will attempt a Cow or Bull, and devour him: And it hath often happened, that one of them alone hath affaulted Boys of ten or twelve Years of Age, and eaten them. Their Colour is black and white, like a Magpie. It is well there are but few of them; for if they were many, they would very much destroy the Cattle. They have on the Fore-part of their Heads, a Comb, not pointed like that of a Cock; but rather even, in the Form of a Razor. When they come to alight from the Air, they make such a humming Noise. with the fluttering of their Wings, as is enough to aftenif, or make a Man deaf.

⁽c) Ecclef. i. 4.

siderable, common Creature, Even a Sparrow (two of which are sold for a Farthing) dothnot fall on the Ground without our heavenly Father.

This Providence of God is remarkable in every Species of living Creatures: But that especial Management of the Recruits and Decays of Mankind, so equally all the World over, deserves our especial Observation. In the Beginning of the World, and so after Noah's Flood, the Longævity of Men, as it was of absolute Necessity to the more speedy Peopling of the new World; so is a special Instance of the Divine Providence in this Matter (d). And the same Providence appears in the following Ages, when the World was pretty well peopled, in reducing the common Age of Man then to 120

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⁽d) The Divine Providence doth not only appear in the Longævity of Man, immediately after the Creation and Flood; but also in their different Longavity at those two Times. Immediately after the Creation, when the World was to be peopled by one Man, and one Woman, the Age of the greatest Part of those on Record, was 900 Years, and upwards. But after the Flood, when there were three Persons by whom the World was to be peopled, none of those Patriarchs, except Shem, arriv'd to the Age of 500; and only the three first of Shem's Line, viz. Arphaxad, Salah, and Eber, came near that Age; which was in the first Century after the Flood. But in the fecond Century, we do not find any reached the Age of 240. And in the third Century, (about the latter End of which Abraham was born, (none, except Terah, arriv'd to 200 Years: By which Time the World was fo well peopled, (that Part of it, at least where Abraham dwelt,) that they had built Cities, and began to be cantoned into distinct Nations and Societies, under their respective Kings; so that they were able to wage War, four Kings against five, Gen, xiv. Nay, if the Accounts of Anian, Berothus, Manetho, and others, yea, Africanus, be to be credited; the World was so well peopled, even before the Times we speak of, as to afford sufficient Numbers for the great Kingdoms of Assyria, Egypt, Persia, &c. But learned Men generally, with great Reason, reject these as legendary Accounts.

Years, (Gen. vi. 3.) in Proportion to the Occasions of the World at that Time. And laftly, when the World was fully peopled after the Flood, (as it was in the Age of Moses, and so down to our prefent Time) the leffening the common Age of Man to 70 or 80 Years (e), (the Age mentioned by Mofes, Pfal. xc. 10. this, I fay,) is manifestly an Appointment of the same Infinite Lord that ruleth the World: For, by this Means, the peopled World is kept at a convenient Stay; neither too full, nor too empty. For if Men (the Generality of them, I mean) were to live now to Methufelah's Age of 969 Years, or only to Abraham's, long after the Flood, of 175 Years, the World would be too much over-run; or if the Age of Man was limited to that of divers other Animals, to ten, twenty, or thirty Years only; the Decays then of Mankind would be too fast: But at the middle Rate mentioned. the Balance is nearly even, and Life and Death keep an equal Pace. Which Equality is fo great and harmonious, and so manifest an Instance of the Divine Management, that I shall spend some Remarks upon it.

If the Reader hath a Mind to fee a Computation of the Increase of Mankind, in the three first Centuries after the Flood, he may find two different Ones of the most learned Archbishop Uper, and Petavius; together with a Refutation of the fo early Beginning of the Affyrian Monarchy; as alfo Reasons for placing Abraham near 1000 Years after the Flood, in our most learned Bishop Stillingsleet's Orig. Sacr. Book III. Chap. 4. Sect. 9.

(e) That the common Age of Man hath been the fame in all Ages fince the World was peopled, is manifest from pro-phane, as well as facred History. To pass by others: Plato lived to the Age of 81, and was accounted an old Man. And those which Pliny reckons up, 1. 7. c. 48. as rare Examples of long Life, may for the most part be match'd by our modern

Histories; especially such as Phny himself gave Credit unto. Dr. Plot hath given us divers Instances in his History of Ox. fordsire, c. 2. sett. 3. and c. 8. sett. 54. and History of Staffordsire, c. 2. sett. 3. and c. 8. sett. 54. and History of Staffordsire, c. 8. sett. 91, &c. Among others, one is of twelve Tenants of Mr. Biddulph's, that together made 1000 Years of Age. But the most considerable Examples of aged Persons among us, is of old Parre of Shropsire, who lived 152 Years. Months, according to the learned Dr. Harvey's Account; and Henry Jenkins of Yorksire, who lived 169 Years, according to the Account of my learned and ingenious Friend Dr. Tanceed Robinson; of both which, with others, see Lowth. Abridg. Phil. Trans. V. 3. p. 306. The great Age of Parre of Shropsire, minds me of an Observation of the Reverend Mr. Plaxton, that in his two Parishes of Kinardsey and Donington in Shropsire, every fixth Soul was 60 Years of Age, or upwards.

And if we step farther North into Scotland, we shall find divers recorded for their great Age: Of which I shall present the Reader with only one modern Example of one Laurence, who married a Wife after he was 100 Years of Age, and would go out to Sea a Fishing in his little Boat, when he was 140 Years old; and is lately dead of no other Distemper but mere old Age, saith Sir Rob. Sibbald, Prodr. His. Nat., Scot. p.

44. and 1. 3. p. 4.

Phil. Trans. No. 310.

As for Foreigners, the Examples would be endless; and therefore that of Job. Ottele shall suffice, who was as famous for his Beard, as for being 115 Years of Age. He was but two Brabant Ells high; and his long grey Beard was one Ell dong. His Picture and Account may be feen in Ephem.

Germ. T. 3. Obf. 163.

As for the Story Roger Bacon tells, of one that lived 900 Years by the Help of a certain Medicine, and many other such Stories, I look upon them as fabulous. And no better is that of the Wandering Jew, named Joh. Buttadaus, said to have been present at our Saviour's Crucifixion; although very serious Stories are told of his being seen at Antwerp, and in France, about the Middle of the last Century but one; and before in Ann. 1542, conversed with by Paul of Eitsen, Bishop of Sleswick; and before that, viz. in 1228, seen and converse with by an Armenian Archbishop's Gentleman; and by others at other Times.

If the Reader hath a Mind to see more Examples, he may meet with some of all Ages, in the learned Hakewill's Apol. p. 181. where he will also find that learned Author's Opinion of the Causes of the Brevity and Length of Human Life. The Brevity thereof he attributeth to a too tender Education, such fucking

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It appears from our best Accounts of these Matters, that in our *European* Parts (f), and I believe the same is throughout the World; that, I say, there is a certain Rate and Proportion in the Propagation

fucking strange Nurses, too hasty Marriages; but above all, to Luxury, high Sauces, strong Liquors, &c. The Longwity of the Ancients he ascribes to Temperance in Meat and Drink, anointing the Body, the Use of Saffron and Honey, warm Clothes, lesser Doors and Windows, less Physick and more Exercise.

(f) The Proportions which Marriages bear to Births, and Births to Burials, in divers Parts of Europe, may be seen at an

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Names of the Places.	Marriages to Births: As	Births to Burials: As
England in General.	I to 4'62	1'12 to 1
London.	1 to 4'	I to I'I
Hantsbire, from 1569, to 1658.	I to 4'	I'2 to I
Tiverton in Devon, 1560, to 1649.	1 to 3'7	
Cranbrook in Kent, 1560, to 1649.	I to 3'9	1'6 to 1
Aynhoin Northamptonfb. for 118 Years.	1 to 6	1'6 to 1
Leeds in Yorksbire for 122 Years.	I to 2'7	1'07 to 1
Harwood in Yorksbire 57 Years.	I to 3'4	1'23 to 1
Upminster in Essex 100 Years.	I to 4'6	1'08 to 1
Frankfort on the Main in 1695.	I to 3'7	1'2 to 1
Old middle & lower Marck in 1698.	I to 3'7	I'9 to I
Domin, of the K. of Prussia in 1698.	1 to 3'7	I's to I
Breflaw in Silefia from 1687, to 1691.		1'6 to 1
Paris in 1670, 1671, 1672.	1 to 4'7	1' to 1'6

Which Table I made from Major Graunt's Observations on the Bills of Mortality; Mr. King's Observations in the first of Dr. Davenant's Essays; and what I find put together by my ingenious Friend Mr. Lowthorp, in his Abridgment, Vol. 3. p. 668. and my own Register of Upminster. That from Aynbo Register in Northamptonspire, I had from the present Rector, the learned and ingenious Mr. Wase: And I was promised some Accounts from the North, and divers other Parts of this Kingdom; but have not yet received them: Only those

pagation of Mankind: Such a Number marry (g), fo many are born, such a Number die; in Proportion to the Number of Persons in every Nation, County, or Parish. And as to Births, two Things are very considerable: One is the Proportion of Males and Females (b), not in a wide Proportion, not an uncertain, accidental Number at all Adventures: but nearly equal. Another Thing is, that a

of Leeds and Harwood in Yorkshire, from my curious and ingenious Friend Mr. Thoresby.

(g) The preceding Table shews, that Marriages, one with another, do each of them produce about four Births; not only

in England, but in other Parts of Europe alfo.

And by Mr. King's Estimate, (the best Computations limagine of any, being derived from the best Accounts; such as the Marriage, Birth, Burial-Act, the Poll-Books, &c. by his Estimate, I say,) about 1 in 104 marry. For he judgeth the Number of the People in England, to be about five Millions and a half; of which about 41000 annually marry. As to what might be farther remarked concerning Marriages, in regard of the Rights and Customs of several Nations, the Age to which divers Nations limited Marriages, &c. it would be Endless, and too much out of the Way to mention them: I shall only therefore, for the Reader's Diversion, take Notice of the Jeer of Lastantius, Quare apud Poetas salacissimus supiter desirt liberos tollere? Utrum sexagenarius sactus, & ei Lex Papia sibulam imposuit? Lactant. Instit. l. 1. c. 16. By which Lex Papia, Men were prohibited to marry after 60, and Women after 50 Years of Age.

(h) Major Graunt, (whose Conclusions seem to be well-grounded,) and Mr. King, disagree in the Proportions they assign to Males and Females. This latter makes in London, 10 Males to be to 13 Females; in other Cities and Market Towns, 8 to 9; and in the Villages and Hamlets, 100 Males to 99 Females. But Major Graunt, both from the London, and Country Bills, saith, there are 14 Males to 13 Females: From whence he justly infers, That Christian Religion, prohibiting Polygamy, is more agreeable to the Law of Nature than Mahu-

metisim, and others that allow it, Chap. 8.

This Proportion of 14 to 13, I imagine is nearly just, it being agreeable to the Bills I have met with, as well as those

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few more are born than appear to die, in any certain Place (i). Which is an admirable Provision for the extraordinary Emergencies and Occasions of the World; to supply unhealthful Places, where Death out-runs Life; to make up the Ravages of great Plagues, and Discases, and the Depradations of War, and the Seas; and to afford a sufficient Number for Colonies in the unpeopled Parts of the Earth. Or on the other Hand, we may fay,

in Mr. Graunt. In the 100 Years, for Example, of my own Parish-Register, although the Burials of Males and Females were nearly equal, being 636 Males, and 623 Females, in all that Time; yet there were baptized 709 Males, and but 675 Females, which is 13 Females to 13'7 Males. Which Inequality shews, not only, that one Man ought to have but one Wife; but also that every Woman may, without Polygamy, have an Husband, if she doth not bar her felf by the Want of Virtue, by Denial, &c. Also this Surplusage of Males is very useful for the Supplies of War, the Seas, and other fuch Expences of the Men above the Women.

That this is a Work of the Divine Providence, and not a Matter of Chance, is well made out by the very Laws of Chance, by a Person able to do it, the ingenious and learned Dr. Arbuthnot. He supposeth Thomas to lay against John, that for eighty two Years running, more Males shall be born than Females; and giving all Allowances in the Computation to Thomas's fide, he makes the Odds against Thomas, that it doth not happen fo, to be near five Millions of Millions, of Millions, of Millions to one; but for Ages of Ages (according to the World's Age) to be near an infinite Number to one against

Thomas. Vid. Phil. Trans. No. 328.

(i) The foregoing Table hews, that in England in general, fewer die than are born, there being but I Death to 1 700 Births. But in London more die than are born. So by Dr. Davenant's Table, the Cities likewise and Market-Towns bury I 700 to one Birth. But in Paris they out-do London, their Deaths being 1 to one Birth: The Reason of which I conceive is, because their Houses are more crowded than in London. But in the Villages of England, there are fewer die than are born, there being but I Death to I 100 Births, And yet Major Graunt, and Dr. Davenant, both observe, that

that sometimes those extraordinary Expences of Mankind, may be not only a just Punishment of the Sins of Men; but also a wise Means to keep the Balance of Mankind even; as one would be ready to conclude, by considering the Asiatick, and other the more fertile Countries, where prodigious Multitudes are yearly swept away with great Plagues, and sometimes War; and yet those Countries are so far from being wasted, that they remain

full of People.

And now upon the whole Matter, What is all this but admirable and plain Management? What can the maintaining, throughout all Ages and Places, these Proportions of Mankind, and all other Creatures; this Harmony in the Generations of Men be, but the Work of One that ruleth the World? Is it possible that every Species of Animals should so evenly be preserved, proportionate to the Occasions of the World? That they should be so well balanced in all Ages and Places, without the Help of Almighty Wisdom and Power? How is it possible by the bare Rules, and blind Acts of Nature, that there should be any tolerable Proportion; for Instance, between Males and Females,

Towns, than are in the Country, notwithstanding the London-Births are fewer than the Country; the Reason of which see in Graunt, Chap. 7. and Davenant, ubi supra, p. 21.

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The last Remark I shall make from the foregoing Table, shall be, that we may from thence judge of the Healthfulness of the Places there mentioned. If the Year 1698 was the mean Account of the three Marcks, those Places bid the fairest for being most Healthful; and next to them Aynho and Cranbrook for English Towns.

either of Mankind, or of any other Creature (k); especially such as are of a serine, not of a domestick Nature, and consequently out of the Command and Management of Man? How could Life and Death keep such an even Pace through all the Animal World? If we should take it for granted, that, according to the Scripture History, the World had a Beginning, (as who can deny it (1)? or if we should suppose the Destruction thereof by Noah's Flood: How is it possible, after the World was replenished,) that in a certain Number of Years, by the greater Increases and Doublings of each Species of Animals; that, Isay, this Rate of Doubling (m) should cease; or, that it should be compensated

(k) Quid loquar, quanta ratio in bestiis ad perpetuam conservationem earum generis appareat? Nam prinium alia Mares, alia Fæmina sunt, quod perpetuitatis causa machinata natura est. Cic. de Nat. Deor. 1. 2. c. 51.

(1) Although Aristotle held the Eternity of the World, yet he seems to have retracted that Opinion, or to have had a different Opinion when he wrote his Metaphysicks; for in his sirft Book he affirms, that God is the Cause and Beginning of all Things; and in his Book de Mundo he saith, There is no Doubt, but God is the Maker and Conservator of all Things in the World. And the Stoick's Opinion is well known, who strenuously contended, That the Contrivance and Beauty of the Heavens and Earth, and all Creatures, was owing to a Wise, Intelligent Agent. Of which Tully gives a large Account in his second Book de Nat. Deer. in the Person of Balbus.

(m) I have before in Note (g), observed, That the ordinary Rate of the Doubling or Increase of Mankind is, that every Marriage, one with another, produces about four Births; but some have much exceeded that. Babo, Earl of Abensperg, had thirty two Sons, and eight Daughters; and being invited to Hunt with the Emperor Henry II. and bring but sew Servants, brought only one Servant, and his thirty two Sons. To these many others might be added; but one of the most remarkable Instances I have any where met with, is that of Mrs. Honywood, mentioned by Hakewill, Camden, and other N 3

pensated by some other Means? That the World should be as well, or better stocked than now it is, in 1656 Years [the Time between the Creation and the Flood; this] we will suppose may be done by the natural Methods of each Species Doubling or Increase: But in double that Number of Years, or at this Distance from the Flood of 4000 Years, that the World should not be over-stocked, can never be made out, without allowing an Infinite Providence.

Authors; but having now before me the Names, with some Remarks, (which I received from a pious neighbouring Descendant of the same Mrs. Honywood) I shall give a more particular Account than they. Mrs. Mary Honywood was Daughter, and one of the Co-heiresses of Robert Atwaters, Esq; of Lenham in Kent. She was Born in 1527, Married in February 1543, at fixteen Years of Age, to her only Husband Robert Honywood, of Charing in Kent, Efq; She died in the ninety-third Year of her Age, in May 1620. She had Sixteen Children of her own Body, seven Sons and nine Daughters; of which one had no Issue, three died young, and the youngest was slain at Newport-Battle, June 20, 1600. Her Grand-Children in the fecond Generation, were one-hundred and fourteen; in the third, two-hundred and twenty-eight; and nine in the fourth Generation. So that she could fay the same that the Distich doth, made of one of the Dalburg's Family of Bafil:

Mater ait Nata, die Nata, filia Natam

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Ut moneat, Nata, plangere Filiolam.

Rife up Daughter, and go to thy Daughter, for her Daughters

Daughter hath a Daughter. Mrs. Honywood was a very pious Woman, afflicted, in her declining Age, with Despair, in some Measure; concerning which, some Divines once discoursing with her, she in a Passion said, She was as certainly damned as this Glass is broken, (throwing a Venice-Glass against the Ground, which she had then in her Hand.) But the Glass escaped breaking, as credible Witnesses attested.

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I conclude then this Observation with the Pfalmist's Words, Pfal. civ. 29, 30. Thou hidest thy Face, all Creatures are troubled; thoutakeft away their Breath, they die, and return to their Duft. Thou sendest forth thy Spirit, they are created; and thou renewest the Face of the Earth.

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C HOATP. XI. SVETSTER OF A

Of the Food of ANIMALS.

HE preceding Reflection of the Pfalmift, mindeth me of another Thing in common to Animals, that pertinently falleth next under Confideration, which is the Appointment of Food, mentioned in Verse 27, 28, of the last cited Pfalm civ. Thefe [Creatures] wait all upon thee, that thou mayest give them their Meat in due Season. That thou givest them, they gather; thou openest thy Hand, they are filled with Good. The same is again afferted in Pfal. cxlv. 15, 16. The Eyes of all wait upon thee, and thou givest them their Meat in due Season. Thou openest thy Hand, and satisfiest the Desire of every living Thing.

What the Plaimist here afferts, affords us a glorious Scene of the Divine Providence and Management. Which, (as I have shewed it to Concern it self in other lesser Things;) so we may presume, doth exert it self particularly in so Grand an Affair asthat of Food, whereby the animal World subsists: And this will be manifested, and the Psalmist's

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Observations exemplified, from these six following Particulars.

I. From the substituting and maintaining such a large Number of Animals, throughout all Parts of the World.

II. From the proportionate Quantity of Food to the Eaters.

III. From the Variety of Food suited to the Variety of Animals: Or, the Delight which various Animals have in different Food.

IV. From the peculiar Food which peculiar Places afford to the Creatures suited to those Places.

V. From the admirable and curious Apparatus made for the Gathering, Preparing, and Digestion of the Food. And,

VI. and Lastly. From the great Sagacity of all Animals, in finding out and providing their Food.

Wisdom, as well as Goodness, to provide Foodsor such a World of Animals (a), as every where possess the Terraqueous Globe; on the dry Land; and in the Sea and Waters; in the torrid and frozen Zones, as well as the temperate. That the temperate Climates, or at least the fertile Valleys, and rich and plentiful Regions of the Earth, should afford Subsistance to many Animals, may appear less wonderful perhaps: But that in all other the most likely Places for Supplies, sufficient Food should be afforded to such a prodigious Number, and so great Variety

(a) Pastum animantibus large & copiose natura eum, qui cuique aptus erat, comparavit. Cic, de Nat. Deo. 1. 2. c. 47.

Ille Deus est, qui per totum orbem armenta dimisit, qui gregibus ubique passim vagantibus pabulum prastat. Senec. de Benes. 1. 4. c. 8.

riety of Beasts, Birds, Fishes, and Insects; is owing to that Being, who hath as wisely adapted their Bodies to their Place and Food, as well as carefully provided Food for their Subsistence there.

But I shall leave this Consideration, because it will be illustrated under the following Points; and

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II. To consider the Adjustment of the Quantity of Food, in Proportion to the Eaters. In all Places there is generally enough; nay, such a Sufficiency, as may be styled a Plenty; but not such a Superfluity, as to waste and corrupt, and thereby annoy the World. But that which is particularly remarkable here, is, that among the great Variety of Foods, the most useful is the most plentiful, most universal, easiest propagated, and most patient of Weather, and other Injuries. As the herbaceous Eaters, (for Instance) are many, and devour much; so the dry-land Surface we find every where almost naturally carpeted over with Grafs, and other agreeable wholfome Plants; propagating themselves in a manner every where, and scarcely destroyable by the Weather, the Plough, or any Art. So likewise for Grain, especially such as is most useful, how easily is it cultivated, and what a large Increase doth it produce ? Phiny's Example of Wheat (b), is a fufficient Instance in this Matter; which (as that curious Heathen observes) being principally useful to the

⁽b) Tritico nibil est fertilius: boc ei natura tribuit, quoniam eo maxime alat hominem; utpote cum è modio, si sit aptum solum——
150 modii reddantur. Mist D. Augusto procurator—ex uno grano (vix credibile distu) 400 paucis minus germina. Mist & Neroni similiter 340 stipulas ex uno grano. Plin, Nat. Deor. l. 18, c. 10.

(c) Sed

the Support of Man, is eafily propagated, and in great Plenty: And an happy Faculty that is of it, that it can bear either Extreams of Heat or Cold

so as scarce to refuse any Clime.

III. Another wife Provision the Creator hath made relating to the Food of Animals, is, that various Animals delight in various Food (c); fome in Grafs and Herbs; some in Grain and Seeds; some in Flesh; some in Insects; some in this (d), somein that; some more delicate and nice; some voracious and catching at any Thing. If all delighted in, on subsisted only with one Sort of Food, there would not be sufficient for all but every Variety chusing various Food, and perhaps abhorring that which others like, is a great and wife Means that every Kind hath enough, and oftentimes somewhat to spare.

It deserves to be reckoned as an Act of the Divine Appointment, that what is wholesome Food to one, is nauseous, and as a Poison to another; what is a sweet and delicate Smell and Tafte to one, is feetid and loathfome to another: By which

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⁽c) Sed illa quanta benigvitas Natura, quod tam multa ad vescet. dum, tam varia, tam jucunda gignit; neque ea uno tempore anni, u semper & novitate delecternur & copia. Cic. de Nat. Deor. 1, 2.

⁽d) Swammerdam observes of the Ephemeron-Worms, that their Food is Clay, and that they make their Cells of the fame. Upon which Occasion he saith of Moths, that eat Wooll and Fur, There are two Things very considerable, 1. That the Cells the make to themselves, wherein they live, and with which (as their House, Tortoise-like) they move from Place to Place, they make if the Matter next at Hand. 2. That they feed alform the same, therefore when you find their Cells, or rather Coats or Cafes to be made of yellow, green, blue, or black Cloth, you will also find their Dung of the same Colour. Swam, Ephem. vita, published by Dr. Tyson, Chap. 3.

Means all the Provisions the Globe affords are well dispos'd of. Not only every Creature is well provided for, but a due Consumption is made of those Things that otherwise would encumber the World. lie in the Way, corrupt, rot, stink and annoy, instead of cherishing and refreshing it. For our most useful Plants, Grain, and Fruits, would mould and rot; those Beasts, Fowls, and Fishes, which are reckoned among the greatest Dainties, would turn to Carrion, and poison us: Nay, those Animals which are become Carrion, and many other Things that are noisome, both on the dry Land, and in the Waters, would be great Annoyances, and breed Difeafes, was it not for the Provision which the Infinite Orderer of the World hath made, by causing these Things to be fweet, pleafant, and wholesome Food to some Creature or other, in the Place where those Things fall: To Dogs, Ravens, and other voracious Animals, for Instance, on the Earth; and to apacious Fishes, and other Creatures inhabiting the Waters.

Thus is the World, in some Measure, kept sweet and clean, and at the same Time, divers Species of Animals supply'd with convenient Food. Which Providence of GOD, particularly in the Supplies afforded the Ravens, is divers Times taken Notice of in the Scriptures (e); but whether for the Reasons now hinted, or any other special Reasons, I shall not enquire. Thus our Saviour, Luke xii. 24. Consider the Ravens; for they neither sow nor reap, which neither have Storehouse, nor Barn, and God feedeth them. It is a manifest Argument

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⁽e) Job xxxviii, 41, Pfal, cxlvii. 9.

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ment of the Divine Care and Providence, in supplying the World with Food and Necessaries, that the Ravens, accounted as unclean, and little regarded by Man, destitute of Stores, and that live by Accidents, by what falleth here and there; that such a Bird, I say, should be provided with sufficient Food; especially if that be true which Aristotle(f), Pliny (g), and Elian (h), report of their unnatural Affection and Cruelty to their Young: "That" they expel them their Nests as soon as they can "fly, and then drive them out of the Country".

Thus having confidered the Wife Appointment of the Creator, in suiting the Variety of Food, to

Variety of Animals: Let us in the

IV. Place, Take a View of the peculiar Food, which particular Places afford to the Creatures in-

habiting therein.

It hath been already observed (i), That every Place on the Surface of the Terraqueous Globe, is stocked with proper Animals, whose Organs of Life and Action are curiously adapted to each respective Place. Now it is an admirable Act of the Divine Providence, That every Place affords a proper Food to all the living Creatures therein. All the various Regions of the World, the different Climates (k), the various Soils, the Seas, the Waters,

(f) Ariftot. 1. 9. c. 31. Hift. Animal.

⁽g) Pliny affirms this of the Crow as well as Raven: Catera omnes [i. e. Cornices] ex codem genere pellunt nidis pullos, ac volare cogum, sicut & Corvi, qui—robustos suos factus sugant longius. Nat. Hist. 1. 10. c. 12.

⁽b) Var. Hift. (i) Chap. 9.

⁽k) Admiranda Natura dispensatio est, ut aliter, alioque modo, tenpore, & industria colatur terra septentrionalis, aliter Ætkiopia, &c.

Waters, nay our very Putrefactions, and most nasty Places about the Globe, as they are inhabited by fome or other Animal, so they produce some proper Food or other, affording a comfortable Subfiftence to the Creatures living there. I might for Instances (1) of this, bring the great Variety of Herbs, Fruits and Grains on the Earth, the large Swarms of Infects in the Air, with every other Food of the Creatures residing in the Earth, or flying in the Air. But I shall stop at the Waters, because the Psalmist, in the fore-cited civth Psalm, speaks with relation to the especial Provision for the Inhabitants of the Waters; and also by reason that many Land-Animals have their chief Maintenance from thence. Now

Quoad Aquilonares, hoc certum est, in plerisque agris Vestroget horum, arte object à Meridionali plaga, Hordeum spatio 36 Dierum à semine rojecto maturum colligi, hoc est, à sine Junii usque medium Augusti, aliquando celerius. Ea namque maturitas ex soli natură, aerisque dementia, ac humore lapillorum sovente radices, Soleque torrente, necesario provenit, ut ita nascatur, ac maturetur, talesque spica sex ordines in numero arista habent. Ol. Mag. Hist. 1. 15. c. 8. Prata a sascua tantâ luxuriant graminum ubertate ac diversitate, ut necessum ît inde arcere jumenta, ne nimio herbarum esu crepent, &c. Id. ib.

. 19. c. 36.

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(1) Among the many noble Contrivances for Food, I cannot but attribute that univerfal Aliment, Bread, to the Reveation, or at least the Inspiration of the Creator and Conservator of Mankind; not only because it is a Food used in all. or most Parts of the World; but especially because it is of ncomparable Use in the great Work of Digestion, greatly issisting the Ferment, or whatever causes the Digestion of he Stomach. Of which take this Example from the noble Mr. Boyle. " He extracted a Menstruum from Bread alone, that would work on Bodies more compact than many hard Minerals, nay even on Glass it self, and do many Things that Aqua-fortis could not do —Yet by no means was this so corrosive a Liquor as Aq. fort. or as the other acid Menstruum". Vid. the ingenious and learned Dr. Harris's Lex, Tech. verbo Menstruum, where the way of preparing it may be met with.

BOOK IV.

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Now one would think, that the Waters were a very unlikely Element to produce Food for so great a Number of Creatures, as have their Subsistence from thence. But yet how rich a Promptuary is it, not only to large Multitudes of Fishes, but also to many amphibious Quadrupeds, Insects, Reptiles, and Birds! From the largest Leviathan, which the Pfalmist saith (m) playeth in the Seas, to the smallest Mite in the Lakes and Ponds, all are plentifully provided for; as is manifest from the Fatness of their Bodies, and the Gaiety of their Aspect and Actions.

And the Provision which the Creator hath made for this Service in the Waters is very observable; not only by the Germination of divers aquatick Plants there, but particularly by appointing the Waters to be the Matrix of many Animals, particularly of many of the Infect-Kind, not only of fuch as are peculiar to the Waters, but also of many appertaining to the Air and the Land, who, by their near Alliance to the Waters, delight to be about them, and by that means become a Prey, and plentiful Food to the Inhabitants of the Wa-And besides these, what prodigious Shoals do we find of minute Animals, even sometimes dicolouring the Waters (n)! Of these (not only in the Water, but in the Air and on Land). I have always thought there was some more than ord-

nary

(m) Pfal. civ. 26.

⁽n) The Infects that for the most part discolour the Waters, are small Infects of the Shrimp-kind, called by Swammer dam, Pulex aquaticus arborescens. These I have often seen so numerous in stagnating Waters in the Summer-Months, that they have changed the Colour of the Waters to a pale of

nary Use intended by the All-wise Creator. And having bent many of my Observations that way, I have evidently found it accordingly to be. For be they never so numberless or minute, those Animals serve for Food to some Creatures or other. Even those Animalcules in the Waters, discoverable only with good Microscopes, are a Repast to others there, as I have often with no less Admiration than Pleasure seen (0).

deep Red; sometimes a Yellow, according to the Colour they were of. Of this Swammerdam hath a pretty Story told him by Dr. Florence Schuyl, viz. Se aliquando Studiis intentum, magno quodam & horrifico rumore fuisse turbatum, & semel ad causam ejus inquirendam excitatum; verum se vix eum in sinem surrexisse, tum Ancilla ejus pæne exanimis adcurreret, multo cum singultu referret, omnem Lugduni [Batavorum] aquam esse mutatam in sanuinem. The Cause of which, upon Examination he sound to be only from the numerous Swarms of those Pulices. V. Swamm. Hist. Insect. p. 70.

The Cause of this great Concourse and Appearance of those little Insects, I have frequently observed to be to perform their Coit; which is commonly about the latter end of May, and in June. At that time they are very venerous, fishing and catching at one another; and many of them conjoined Tail to Tail, with their Bellies inclined one towards

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At this time also they change their Skin or Slough; which I tonceive their rubbing against one another mightily promoteth. And what if at this Time they change their Quarters?

Vid. Book VIII. Chap. 4. Note (f).

These small Insects, as they are very numerous, so are Food to many Water-Animals. I have seen not only Ducks shovel them up as they swim along the Waters, but divers Insects also devour them, particularly some of the middle-fized

Squilla aquatica, which are very voracious Infects.

(0) Besides the Pulices last mentioned, there are in the Waters other Animalcules very numerous, which are scarce visible without a Microscope. In May, and the Summer Months, he green Scum on the Top of stagnating Waters, is nothing else but prodigious Numbers of these Animalcules: So is ikewise the green Colour in them, when all the Water seems green. Which Animalcules, in all Probability, serve for

But now the usual Objection is, that Necessity maketh Use (p). Animals must be fed, and they make use of what they find: In the desolate Regions, and in the Waters, for Instance, they feed upon what they can come at; but, when in greater Plenty, they pick and chuse.

But this Objection hath been already in some measure answered by what hath been said; which

plainly

Food to the Pulices Aquatici, and other the minuter Animals of the Waters. Of which I gave a pregnant Instance in one of the Nympha of Gnats, to my Friend the late admirable Mr. Ray, which he was pleased to publish in the last Edition of his Wisdom of God in the Creation, p. 430.

(p) Nil adeò quoniam natum'st in Corpore, ututi Possemus, sed quod natum'st, id procreat usum.

And afterwards,
Propterea capitur Cibus, ut suffulciat artus,
Et recreet vireis interdatus, atque patentem
Per membra ac venas ut amorem obturet edendi.

And after the same manner he discourseth of Thirst, and

divers other Things. Vid. Lucret. 1. 4. v. 831, 80c.

Against this Opinion of the Epicureans, Galen ingeniously argues in his Discourse about the Hand. Non enim Manus ipsa (saith he) hominem artes docuerunt, sed Ratio. Manus autem ipse sunt artium organa; sicut Lyra musici-Lyra musicam non docuit, sed est ipsius artifex per eam, qua præditus est, Rationem : agm autem non potest ex arte absque organis, ita & una qualibet animasa. cultates quasdam à sua ipsius substantia obtinet, - Quod autem coporis particula animam non impellunt, - manifeste videre licet, s animalia recens nata consideres, qua quidem prius agere conantur, quam perfectas habeant particulas. Ego namque Bovis vitulum comibus petere conantem sepenumero vidi, antequam ei nata essent comua; Et pullum Equi calcitrantem, &c. Omne enim animal sua iffin Anima facultates, ac in quos usus partes sua polleant maxime, num doctore, prasentit. Qua igitur ratione dici potest, animalia partium usus à partibus doceri, cum & antequam illas habeant, hoc cognoscent videantur? Si igitur Ova tria acceperis, unum Aquila, alterum Anatis, reliquum Serpentis. & calore modico foveris, animaliaque excluseris; illa quidem alis volare conantia, antequam volare possint; boc autem revolvi videbis, & serpere affectans, quamvis molle adhuc & invalidum fuerit. Et si, dum perfecta erunt, in una eademque domo nutriveris, pla dor of I ver nau a m is n the that cide

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deinde Anas malia quam Galer plainly argues Design, and a super-intending Wisdom, Power and Providence in this special Business
of Food. Particularly the different Delight of divers Animals in different Food, so that what is
nauseous to one, should be Dainties to another, is
a manifest Argument, that the Allotment of Food
is not a Matter of mere Chance, but entailed to
the very Constitution and Nature of Animals;
that they chuse this, and refuse that, not by Accident, or Necessity, but because the one is a
proper Food, agreeable to their Constitution, and
so appointed by the Infinite Contriver of their
Bodies; and the other is disagreeable and injurious
to them.

But all this Objection will be found frivolous, and the Wisdom and Design of the Great Creator will demonstratively appear, if we take a Survey,

V. Of the admirable and curious Apparatus in all Animals, made for the Gathering, Preparing and Digestion of their Food. From the very first Entrance, to the utmost Exit of the Food, we find every Thing contrived, made and disposed with the utmost Dexterity and Art, and curiously adapted to the Place the Animal liveth in, and the Food it is to be nourished with.

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Let us begin with the Mouth. And this we find, in every Species of Animals, nicely conformable to the Use of such a Part; neatly sized and shaped for the catching of Prey, for the gathering or rescriving

deinde ad locum subdialem ducta emiseris, Aquila quidem ad sublime ;

Anas autem in paludem; — Serpens verò sub terrà irrepet — Animalia quidem mibi videntur Naturà magis quàm Ratione artem aliquam [rexvina artissicosa] exercere: Apes singere alveolos, &c. Galen de usu Part. 1, c. 3.

ceiving Food (q), for the Formation of Speech, and every other such like Use (r). In some Creatures it is wide and large, in some little and narrow; in some with a deep Incisure up into the Head (r), for the better catching and holding of Prey, and more easy Comminution of hard, large and troublesome Food; in others with a much shorter Incisure, for the gathering and holding of herbaceous Food.

In Infects it is very notable. In some forcipated; to catch hold and tear their Prey (t). In some

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(1) Among Infects, the Squille aquotice, as they are very rapacious, fo are accordingly provided for it: Particularly

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⁽q) Alia dentibus praduntur, alia unguibus, alia rostri aduncitate carpunt, alia latitudine [ejusdem] ruunt, alia acumine excavant, alia sugunt, alia lambunt, sorbent, mandam, vorant. Nec minor varietas in pedum ministerio, ut rapiant, distrabant, teneant, premant, pendeant tellurem scabere non cessent. Plin. Nat. Hist. l. 10. c. 71.

⁽r) Because it would be tedious to reckon up the Bones, Glands, Mascles, and other Parts belonging to the Mouth, it shall suffice to observe, that, for the various Services of Man's Mouth, besides the Muscles in common with other Parts, there are five Pair, and one single one proper to the Lips only, as Dr. Gibbon reckons them: But my most diligent and curious Friend the late Mr. Cowper, discovered a fixth Pair. And accordingly Dr. Drake reckons six Pair, and

one fingle one proper to the Lips, 1. 3. c. 13.

(s) Gaden deferves to be here consulted, who excellently argues against the casual Concourse of the Atoms of Epicarus and Asclepiades, from the provident and wise Formation of the Mouths of Animals, and their Teeth answerable thereto. In Man, his Mouth without a deep Incisure, with only one canine Tooth on a side, and flat Nails, because, saith he, Hic Natura certo sciebas, se animal mansuetum accivit effingere, casi volume vires effent on sapientia, nan ex comprissortitudus. But for Lions, Wolfs and Dogs, and all such as are called Karxardovers, (or having sharp, serrated Teeth) their Mouths are large, and deep cut; Teeth strong and sharp, and their Nails sharp, large, strong and round, accommodated to holding and tearing. Vid. Galen. de Us Part 1. 11. c. 9.

CHAP. XI. Of Animals Mouths. 195 aculeated, to pierce and wound Animals (u), and such their Blood. And in others strongly rigged with Jaws and Teeth, to gnaw and scrape out their Food,

the Squilla aquatica maxima recurva (as I call it) who hath somewhat terrible in its very Aspect, and in its Posture in the Water, especially its Mouth, which is armed with long, sharp Hooks, with which it boldly, and greedily catcheth any rhing in the Waters, even one's Fingers. When they have seized their Prey, they will so tenaciously hold it with their forcipated Mouth, that they will not part therewith, even when they are taken out of the Waters, and jumbled about in one's Hand. I have admired at their peculiar way of taking in their Food; which is done by piercing their Prey with their Forcipes (which are hollow) and sucking the Juice thereof through them.

The Squilla here mentioned, is the first and second in

Monffet's Theat. Infett. 1. 2. c. 37.

(n) For an Instance of Insects endued with a Spear, I shall, for its Peculiarity, pitch upon one of the smallest, if not the very smallest of all the Gnat-kind, which I call, Culer minimus nigricans maculatus sanguisuga. Among us in Essex, they are called Nidiots; by Monsset, Midges. It is about one tenth of an Inch, or somewhat more, long, with short Antenna, plain in the Female, in the Male feather'd, somewhat like a Bottle-Brush. It is spotted with blackish Spots, especially on the Wings, which extend a little beyond the Body. It comes from a little slender Eel-like Worm, of a dirty white Colour, swimming in stagnating Waters by a wrighing Motion; as in Fig. 5.

lts Aurelia is small, with a black Head, little short Horns, a spotted, slender, rough Belly. Vid. Fig. 6. It lies quietly on the top of the Water, now and then gently wagging it self

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These Gnats are greedy Blood-Suckers, and very troublefome, where numerous; as they are in some Places near the
Thames, particularly in the Breach-Waters that have lately
befallen near us, in the Parish of Dagenham; where I found
them so vexatious, that I was glad to get out of those Marshes.
Yea, I have seen Horses so stung with them, that they have
had Drops of Blood all over their Bodies, where they were
wounded by them.

I have given a Figure (in Fig. 7.) and more particular Description of the Guais, because, although it be commons

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Food, to carry Burdens (w), to perforate the Earth, yea the hardest Wood, yea even Stones themselves, for Houses (x) to themselves, and Nests for their

young.

And lastly, in Birds it is no less remarkable. In the first Place, it is neatly shaped for piercing the Air, and making Way for the Body through the airy Regions. In the next Place, it is hard and horny, which is a good Supplement for the want of Teeth, and causeth the Bill to have the Use and Service of the Hand. It's hooked Form is of great Use to the rapacious Kind (y), in catching and holding their Prey, and in the Comminution thereof by tearing; to others it is no less serviceable to their Climbing, as well as neat and nice Comminution of their Food (z). Its extraordinary Length and Slenderness is very useful to some, to search and

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it is no where taken notice of by any Author I know, except Mouffet, who, I suppose, means these Gnats, which he calls Midges, c. 13. p. 82.

(w) Hornets and Wasps have strong Jaws, toothed, where with they can dig into Fruits, for their Food; as also gnaw and scrape Wood, whole Mouthfuls of which they carry away to make their Combs. Vid. infr. Chap. 13. Note (c).

(x) Monsieur de la Voye tells of an ancient Wall of Free-Stone in the Benedictines-Abbey at Caen in Normandy, so eaten with Worms, that one may run ones Hand into most of the Cavities: That these Worms are small and black, lodging in a greyish Shell; that they have large flattish Heads, a large Mouth, with four black Jaws, &c. Phil. Trans. No. 18.

(y) Pro iis [Labris] cornea & acuta Volucribus Rostra. Eadem rapto viventibus adunca: colletto, recta: herbas ruentibus limumque lata, ut Suum generi. Jumentis vice manûs ad colligenda pabula: ora apertiora laniatu viventibus. Plin. Nat. Hist. 1. 11. c. 37.

(2) Parrots have their Bills nicely adapted to these Services, being hooked, for climbing and reaching what they have occasion for; and the lower Jaw being compleatly fitted to

grope for their Food in moorish Places (aa); as its Length and Breadth is to others to hunt and fearch in muddy Places (bb): And the contrary Form, namely, a thick, short, and sharp-edged Bill, is as useful to other Birds, who have occasion to husk and flay the Grains they swallow. But it would be endless, and tedious, to reckon up all the various Shapes, and commodious Mechanism of all; the Sharpness and Strength of those who have Occasion to perforate Wood and Shells (cc); the Slenderness and Neatness of such as pick up small Insects; the Cross-form of such as break up Fruits (dd); the compressed Form of others (ee), with

the Hooks of the upper, they can as minutely break their Food, as other Animals do with their Teeth.

(aa) Thus in Woodcocks, Snipes, &c. who hunt for Worms in moorish Ground, and, as Mr. Willinghby saith, live also on the fatty uncluous Humour ney suck out of the Earth. So also the Bills of Curlows, and many other Sea-Fowl, are very long, to enable them to hunt for the Worms, &c. in the Sands on the Sea-shore, which they frequent.

(bb) Ducks, Geefe, and divers others, have such long broad Bills, to quaffer and hunt in Water and Mud; to which we may reckon the uncouth Bill of the Spoon-Bill: but that which deserves particular Observation in the Birds named in these two last Notes is, the Nerves going to the end of their Bills, enabling them to discover their Food out of Sight; of which see Book VII. Chap. 2. Note (e).

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(cc) The Picus viridis, or Green-Woodspite, and all the Wood-Peckers have Bills curiously made for digging Wood, strong, hard, and sharp. A neat Ridge runs along the top of the green Wood-Pecker's Bill, as if an Artist had designed it for Strength and Neatness.

(dd) The Loxia, or Cross-Bill, whose Bill is thick and strong, with the Tips croffing one another; with great Readiness breaks open Fir-cones, Apples, and other Fruit, to come at their Kernels, which are its Food, as if the croffing of the Bill was designed for this Service.

(ee) The Sea-Pie hath a long, fharp, narrow Bill, compressed side-ways, and every way so well adapted to the raising 198 Of Animals Mouths. Book IV.

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many other curious and artificial Forms, all suited to the Way of Living, and peculiar Occasions of the several Species of Birds. Thus much for the Mouth.

Let us next take a short View of the Teeth (ff), In which their peculiar Hardness (gg) is remarkable, their Growth (bh) also, their firm Insertion and Bandage in the Gums and Jaws, and their various Shape and Strength, suited to their various Occasion and Use (ii); the foremost weak and farthest

Limpets from the Rocks (which are its chief, if not only Food) that Nature (or rather the Author of Nature) feems to have framed it purely for that Use.

'(ff) Those Animals which have Teeth on both Jaws, have but one Stomach; but most of those which have no upper Teeth, or none at all, have three Stomachs; as in Beasts, the Paunch, the Read, and the Feck; and in all granivorous Birds, the Crop, the Echinus and the Gizard. For as chewing is an easy Digestion, so is swallowing whole to that which is more laborious. Dr. Grew's Cosmol. Sacr. c. 5, Sect. 24.

(gg) F. Peyer saith, the Teeth are made of convolved Skins hardened; and if we view the Grinders of Deer, Horses, Sheep, &c. we shall find great Reason to be of his Mind. His Observations are, Misum autemeos (i. e. Dentes) cum primum è pelliculis imbricatim convolutis & muco viscido constarent, in tantam diriges, cere soliditatem, qua ossa euneta superet. Idem sit etiam in Ossiculis Cerasorum, &c. Separatione sasta, per membranas conditur Magna locellis, quos formant lamina tenues, ac durinscula ad Dentis siguram anteàdivinitus composita. J. Peyer Merycol. 1. 2. c. 8.

(bh) Qui autem (i. e. Dentes) renascuntur, minime credendi sunt à facultate aliquâ plastica Brutorum denuo formari, sed latentes tantum-modo in conspectum producuntur augmento molis ex effluente succo. Id. jbid.

(ii) From these, and other like Considerations of the Teeth, Galen infers, That they must needs be the Work of some Wise, Provident Being; not Chance, nor a fortuitous Concourse of Atoms. For the Consirmation of which he puts the Case, That suppose the Order of the Teeth should have been inverted, the Grinders set in the room of the Incifors, Sec. (which might as well have been, had not the Teeth

farthest from the Center, as being only Preparers to the rest; the others being to grind and mince, are accordingly made stronger, and placed nearer the Center of Motion and Strength. Likewise their various Form (kk), in various Animals is considerable, being all curiously adapted to the peculiar Food (11), and Occasions of the several Species of Animals (mm). And lastly, the temporary Defect

been placed by a wise Agent) in this Case, What Use would the Teeth have been of? What Consuson by such a slight Error in their Disposal only? Upon which he argues, At siquis choream hominum 32 (the Number of the Teeth) ordine disposal, eum ut hominum industrium landaremus: chim verò Dennium choream Natura tam belle exornàrit, nonne insam quoque laudabimus? And then he goes on with the Argument, from the Sockets of the Teeth, and their nice sitting in them, which being no less accurately done, than what is done by a Carpenter, or Stane-Cutter, in sitting a Tenon into a Mortice, doth as well infer the Art and Act of the Wise Maker of Animal Bodies, as the other doth the Act and Art of Man. And so he goes on with other Arguments to the same Effect. Galen, de Us. Part. 1. 11. c. 8.

(kk) A curious Account of this may be found in an Extract of a Letter concerning the Teeth of divers Animals. Printed at Paris, in M. Vauguion's Compleat Body of Chirurg. Oper. Chap. 53.

(11) As it hath been taken Notice of, that various Animals delight in various Food; so it constantly falls out, that their Teeth are accordingly fitted to their Food; the rapacious to catching, holding and tearing their Prey; the herbaceous to Gathering and Comminution of Vegetables: And such as have no Teeth, as Birds, their Bill, Craw and Gizard, are affished with Stones, to supply the defect of Teeth. But the most considerable Example of this Kind is in some Families of the Insect-Tribes, as the Papillio-Kind, &c. who have Teeth, and are voracious, and live on tender Vegetables in their Nympha, or Caterpillar-State, when they can only creep; but in their mature Papillio-State, they have no Teeth, but a Proboscis, or Trunk, to suck up Honey, &c. their Parts for gathering Food, as well as their Food being changed, as soon as they have Wings to enable them to sty to it.

(mm) It is remarkable in the Teeth of Fishes, that in some they

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fect of them (nn), is no less observable in Children, and such young Creatures, where there is no Occasion for them; but they would be rather an Annoy-

ance to the tender Nipples and Breafts.

From the Teeth, the grand Instruments of Massication; let us proceed to the other ministerial Parts. And here the Parotid, Sublingual, and maxillary Glands; together with those of the Cheeks and Lips, are considerable; all lodged in the most convenient Places about the Mouth and Throat, to afford that noble digestive salival Liquor, to be mixed with the Food in Massication, and to moisten and subricate the Passages, to give an easie descent to the Food. The commodious Form also of the Jaws, deserves our Notice: together with the strong Articulation of the lowermost, and its Motion. And lastly, the curious Form, the great Strength, the convenient Lodgment and Situation of the several Muscles and Tendons (00), all

they are sharp, as also jointed, so as to fall back, the better to catch and hold their Prey, and to facilitate its Passage into the Stomach: So in others they are broad and flat, made to break the Shells of Snails and Shell-Fish devoured by them. These Teeth, or Breakers, are placed, in some, in the Mouth; in some, in the Throat; and in Lobsters, &c. in the Stomach it self; in the bottom of whose Stomachs are three of those Grinders, with peculiar Muscles to move them.

(nm) What is there in the World can be called an Act of Providence and Defign, if this temporary Defect of Teeth be not such: That Children, for Instance, should have none whilst they are not able to use them, but to hurt themselves, or the Mother; and that at the very Age when they can take in more substantial Food, and live without the Breast, and begin to need Teeth, for the sake of Speech; that then, I say, their Teeth should begin to appear, and gradually grow, as they more and more stand in need of tem.

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CHAP. XI. Of Animals Mouths. 20

ministring to this so necessary an Act of Life, as Mastication is; they are such Contrivances, such Works, as plainly set forth the Infinite Workman's

Care and Skill.

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Next to the Mouth, the Gullet presenteth it self; in every Creature well-siz'd to the Food it hath occasion to swallow; in some but narrow, in others as large and extensive (pp); in all exceedingly remarkable for the curious Mechanism of its Muscles, and the artificial Decussation and Position of their Fibres (qq).

And

fore I shall refer to the Anatomists; among the rest, particularly to Galen, for the sake of his Descant upon this Subject. For having described the great Accuracy of the Contrivance and Make of these Parts, he saith, Haud scio an hominum sit sobriorum ad Fortunam opisicem id revocare: alioqui quid tandem erit, quod cum Providentia atque Arte efficitur? Omnino enim hoc ei contrarium esse debet, quod casu ad fortuito sit. Galen. de Us. Part.

I. II. c. 7. ubi plura.

(pp) The Bore of the Gullet is not in all Creatures alike answerable to the Body or Stomach. As in the Fox, which both feeds on Bones, and swallows whole, or with little chewing; add next in a Dog, and other sivorous Quadrupeds, this very large, viz. to prevent a Contusion there in. Next in a Horse, which though he feeds on Grass, yet swallows much at once, and so requires a more open Passage. But in a Sheep, Rabbit, or Ox, which bite sort, and swallow less at once, this smaller. And in a Squirrel, still lesser, both because he eats sine, and to teep him from discorging his Meat upon his descending Leaps. And so n Rats and Mice, which often run along Walls, with their Heads swalloweds. Dr. Grew's Comp. Anat. of Stom. and Guts, Chap. 5.

(99) Of this fee Dr. Willis's Pharm, Rat. Part 1. Sect. 1. c. 2.

Steno also, and Peyer Mery, 1. 2.

The Description these give of the muscular Part of the Gullet, the late ingenious and learned Dr. Drake saith is very xact in Ruminants, but not in Men. In Men, this Coat (the econd of the Gullet) consists of two slepy Lamellae, like two disinct Muscles. The outward being composed of strait longitudinal libres.—The inner Order of Fibres is annular, without any observate Angles.—The Use of this Coat, and these Orders of Fibres, is to romote Deglutition; of which the Longitudinal,—forten the Oeso-

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202 Of Animals Throats. BOOK IV.

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And now we are arriv'd to the grand Receptaele of the Food, the Stomach; for the most Part as various as the Food to be convey'd therein. And here I might describe the admirable Mechanilm of its Tunicks, Muscles, Glands, the Nerves, Arteries, and Veins (rr); all manifesting the super-eminent Contrivance and Art of the Infinite Workman (ss); they being all nicely adjusted to their respective Place, Occasion and Service. I might also insist upon that most necessary Office of Digestion; and here consider that wonderful Faculty of the Stomachs of all Creatures, to dislolve (#) all the feveral Sorts of Food appropriated to their Species; even fometimes Things of that Confiftency as feem Infoluble (mu); especially by such feem-

phagus, and so make its Capacity larger, to admit of the Matter tobe swallowed. The Annular, on the contrary, contract the Capacity, and closing behind the descending Aliment, press it downwards. Drakes Anat. vol. 1. 1. 1. C. 9.

(rr) See Willis, ibid. Comper's Anat. Tab. 35. and many

other Authors.

REMEDIA

(ss) Promptuarium autem boc, alimentum universum excipieu, ceu Divinum, non Humanum sit opisicium. Galen. de Us. Part. 1. 4. c. 1.

(tt) How great a Comprehension of the Nature of Things, did it is quire, to make a Monstruum, that hould corrode all sorts of supporting into the Stomach, and yet not the Stomach it self, which is also

Fleft? Dr. Grew's Cofmol. Sacr. c. 4.

⁽uu) The Food of the Castor being oftentimes, if not always, dry Things, and hard of Digestion, such as the Roos and Bark of Trees, 'tis a wonderful Provision made in that Creature's Stomach, by the digestive Juice lodged in the curious little Cells there. A Description of whose admirable Structure and Order may be found in Blasius from Wester; concerning which he saith, In quibus Mucus reconditus, non seen ac Med in Facis. Nimirum quia Casteris adimentum exsucum, o cotu dississimum est, sapientissimus en summe admirandus in sui operibus rerum Conditor, D.O. M. ipsi pub berrima ista en affabre salva

CHAP. XI. Of Animals Stomachs, 203

feemingly simple and weak Menstraums as we find in their Stomachs: But I shall only give these Things a bare mention, and take more peculiar Notice of the special Provision made in the particular Species of Animals, for the Digestion of that

special Food appointed them.

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And in the first Place it is observable, that, in every Species of Animals, the Strength and Size of their Stomach (ww) is conformable to their Food. Such whose Food is more delicate, tender, and nutritive, have commonly this Part thinner, weaker, and less bulky; whereas such whose Aliment is less nutritive, or whose Bodies require larger Supplies to answer their Bulk, their Labours, and waste of Strength and Spirits, in them it is arge and strong.

Another very remarkable Thing in this Part, is, he Number of Ventricles in divers Creatures. In

many

ructura benignissime prospenit, ut nunquam deesset Fermentum, quod ad dvendum, & comminuendum alimentum durum & asperum par foret. Vid. Blas. Anat. Animal. c. 10. Confer etiam Act. Erud. Lips. Ann. 1684. p. 360.

Most of our Modern Anatomists and Physicians attribute Digestion to a dissolving Menstruum; but Dr. Drake takes it to be rather from fermentative, dissolving Principles in the diment it self, with the Concurrence of the Air and Heat of he Body; as in Dr. Papin's Digester, Vid. Dr. Anat. vol. 1.c. 14.

(ww) All carnivorous Quadrupeds bave the smallest Ventricles, less going farthest. Those that seed on Fruits, and Roots, have them so a middle Size. Tet the Mole, because it seeds unclean, hath a very reat one. Sheep and Oxen, which feed on Grass, have the greatest, et the Horse (and for the same Reason the Coney and Hare) though raminivorous, yet comparatively have but little ones. For that a Horse imade for Labour, and both this, and the Hare, for quick and continued Motion; for which the most easy Respiration, and so the freest Motion of the Diaphragm is very requisite; which yet could not be, hould the Stomach lie hig and cumbersome upon it, as in Sheep and Oxen it doth. Grew, ib. Chap. 6. (xx) The

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many but one; in some two or more (ax). In such as make a sufficient Comminution of the Food in the Mouth, one suffices. But where Teeth are wanting, and the Food dry and hard, (as in granivorous Birds), there the Defect is abundantly supply'd by one thin membranaceous Ventricle, to receive and moisten the Food, and another thick, strong, muscular one, to grind and tear (yy) it. But in such Birds, and other Creatures, whose Food is not Grain, but Flesh, Fruits, Insects, or partly one, partly the other, there their Stomachs are accordingly conformable to their Food (zz), stronger or weaker, membranaceous or muscular.

But as remarkable a Thing as any in this Part of Animals, is, the curious Contrivance and Fabrick of the several Ventricles of ruminating Creatures. The very Act it self of Rumination, is an excellent Provision for the compleat Mastication of the Food, at the Resting, leisure Times of the Animal. But the Apparatus for this Service, of divers Ventricles

(xx) The Dromedary hath four Stomachs, one whereof peculiarly endowed with about twenty Cavities, like Sacks in all Probability for the holding of Water. Concerning which, fee Book VI. Chap. 4. Note (a).

(yy) To affift in which Office, they swallow small angular Stones, which are to be met with in the Gizards of all gramworous Birds; but in the Gizard of the Iynx, or Wrynd, which was full only of Ants, I found not one Stone. So it that of the Green Wood-Pecker (full of Ants and Tree-Maggot) there were but few Stones.

⁽zz) In most carnivorous Birds, the third Ventricle is Membranous; where the Meat is concessed, as in a Man: Or somewhat Tendinous, as in an Owl; as if it were made indifferently for Flesh, or other Meat, as be could meet with either. Or most thick and tendinous, called the Gizard; wherein the Meat, as on a Mill, is ground to Pieces. Grew, whi supra, Chap. 9.

CHAP. XI. Of Animals Stomachs. 205 tricles for its various Uses and Purposes, together with their curious Mechanism, deserves great Admiration (aaa).

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Having thus far pursu'd the Food to the Place; where by its Reduction into Chyle, it becomes a proper Aliment for the Body; I might next trace through the several Mæanders of the Guts, the Latteals, and so into the Blood (bbb), and afterwards.

(aaa) It would be much too long a Task to infist upon it here as it deserves, and therefore concerning the whole Business of Rumination, I shall refer to F. Conv. Peyeri Merycolog. in de Ruminatibus & Ruminatione Commentar, where he large, y treateth of the several Ruminating Animals, of the Parts ninistring to this Act, and the great Use and Benefit therefunto them.

(bbb) There are too many Particulars to be infifted on, obervable in the Passages of the Chyle, from the Guts to the Left Subclavia Vein, where it enters into the Blood; and thereore I shall only, for a Sample of this admirable OEconony, take Notice of some of the main and more general Matters. And,

1. After the Food is become Chyle, and gotten into the Guts, it is an excellent Provision made, not only for its Paflage through the Guts, but also for its Protrusion into the Latteals, by the Perifialtick Motion, and Valvula Conneventes of the Guts. 2. It is an admirable Provision, that the Mouths of the Lacteals; and indeed the Lacteals primi generis themselves are small and fine, not wider than the Capillary Arteries are, lest by admitting Particles of the Nourishment groffer than the Capillaries, dangerous Obstructions might be thereby produced. 3. After the Reception of the Aliment into the Lacteals primi generis, it is a noble Provision for the Advancement of its Motion, that in the Mesenterick Glands, it meets with some of the Lympha-Ducts, and receives the Impregnations of the Lympha. And passing on from thence, it is no less Advantage. 4. That the Latteals, and Lympha-Dutts meet in the Receptaculum Chyli, where the Aliment meeting with more of the Lympha, is made of a due Confiftence and Temperament, for its farther Advancement through the Thoracick Duct. and so into the Left Subclavian Vein and Blood. Lastly, This Thoracick Dust it felf is a Part of great Confideration. For

(as

(as Mr. Couper faith) If we confider in this Duct its several Divisions and Inosculations, its numerous Valves looking from below upwards, its advantageous Situation between the great Artery and Vetebræ of the Back, together with the Ducts discharging their refluent Lymphasisms the Lungs, and other neighbouring Parts, we shall find all conduce to demonstrate the utmost Art of Nature used in surthering the steep and perpendicular Ascent of the Chyle. Anat. Introduct.

(ccc) These, although noble Contrivances and Works of God, are too many to be insisted on, and therefore I shall refer to the Anatomists, particularly Dr. Willis Pharmaceut, Dr. Cole, in Phil. Trans. No. 125. and Mr. Cowper's elegant Cut in

Anat. Tab. 34, 35. and Append. Fig. 39, 40.

(ddd) In the Thornback, and some other Fishes, it is a very curious Provision that is made to supply the Paucity and Brevity of the Guts; by the Perforation of their single Gut, going out strait along, but round like a Pair of Winding-Stairs; so that their Gut, which seems to be but a few Inches long, hath really a Bore of many Inches. But of these, and many other noble Curiosities and Discoveries in Anatomy, the Reader will, I hope, have a better and larger Account from the curious and ingenious Dr. Dowglas, who is labouring in those Matters.

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CHAP. XI. Of Animals Stomachs.

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the Chyle, and to make amends for the Shortness of the Intestines, in such Creatures who have but one Gut; together with many other Accommodations of Nature in particular Animals that might be mentioned. But it shall suffice to have given only a general Hint of those curious and admirable Works of God. From whence it is abundantly manifest, how little Weight there is in the former atheistical Objection. Which will receive a further Confutation from the

VI. and last Thing relating to Food, that I shall fpeak of, namely, The great Sagacity of all Aninals, in finding out and providing their Food. In Man, perhaps, we may not find any Thing very admirable, or remarkable in this Kind, by Means of his Reason and Understanding, and his Supremacy over the inferiour Creatures; which answerth all his Occasions relating to this Business: But then even here the Creator hath shewed his Skill, in not over-doing the Matter; in not providing Man with an unnecessary Apparatus, to effect over and over again what is feafible, by the Reach of his Understanding, and the Power of his Authority.

But for the inferiour Creatures, who want Reaion, the Power of that natural Instinct, that Sagatity (eee) which the Creator hath imprinted upon them, do amply compensate that Defect. And here we shall find a glorious Scene of the Divine Wifdom.

⁽eee) Quibus bestiis erat is cibus, ut alius generis bestiis vescerentur, aut vires natura dedit, aut celeritatem : data est quibusdam etiam machinatio quedam, atque solertia, &c. Cic. de Nat. Deor. 1. (fff) Among

Wisdom, Power, Providence and Care, if we view the various Instincts of Beasts, great and small, of Birds, Infects, and Reptiles (fff). For among every Species of them, we may find notable Acts of Sagacity, or Instinct, proportional to their Occafions for Food. Even among those whose Food is near at Hand, and eafily come at; as Grass and Herbs; and consequently have no great need of Art to discover it; yet, that Faculty of their accurate Smell and Tafte, fo ready at every turn, to distinguish between what is falutary, and what pernicious (ggg), doth justly deserve Praise. But for fuch Animals, whose Food is not so easily come at. a Variety of wonderful Instinct may be met with. sufficient to entertain the most curious Observer. With what entertaining Power and Artifice do some Creatures hunt (bbb), and pursue their Game and

(fff) Among Reptiles that have a strange Faculty to shift for Food, &c. may be reckoned Eels, which, although belonging to the Waters, can creep on the Land from Pond to Pond, &c. Mr. Mosely of Mosely, saw them creep over the Meadows, like so many Snakes from Ditch to Ditch; which he thought, was not only for bettering their Habitation, but also to catch Snails in the Grass. Plot's History of Staffordbire, c. 7. sect. 32.

And as early as the Year 1125, the Frost was so very intense, that the *Fels* were forced to leave the Waters, and were frozen to Death in the Meadows. Vide Hakewill's Apol. 1. 2. chap. 7. sect. 2.

(ggg) Enumerare possum, ad pastum capessendum consiciendumque, qua sit in siguris animantium of quam solers, subtilisque descripio partium, quamque admirabilis fabrica membrorum. Omnia enim qua intus inclusa sunt, ita nata, atque ita locata sunt, ut nibil eorum supervacaneum sit, vibil ad vitam retinendam non necessarium. Dedit autem eadem Natura belluis of sensum, of appetitum, ut altero conatum haberent ad naturales pastus capessendos; altero secernerent pestifera à salutaribus. Cic. de Nat. Deor. l. 2. c. 37. See Book IV. Chap. 4.

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⁽¹⁴¹⁶⁾ It would be Endless to give Instances of my own and others

and Prey! And others watch and way-lay theirs (iii)! With what prodigious Sagacity do others grope for it under Ground, out of Sight, in moorish Places, in Mud and Dirt (kkk); and others dig

others Observations, of the prodigious Sagacity of divers Animals in Hunting, particularly Hounds, Setting-Dogs, &c. one therefore thall fuffice of Mr. Boyle's, viz. A Person of Quality -to make a Trial, whether a young Blood-Hound was well instructed, ____caused one of his Servants _____to walk to a Town four Miles off, and then to a Market-Town three Miles from thence____ The Dog; without seeing the Man be was to pursue, followed him by the Scent to the above-mentioned Places, notwithstanding the Multitude of Market-People that went along in the same Way, and of Travellers that had Occasion to cross it. And when the Blood Hound canie to the shief Market-Town, he passed through the Streets, without taking Notice of any of the People there, and left not till he had gone to the House, where the Man be fought rested himself, and found him in an upper Room, to the Wonder of those that followed him. Boyl, determ. Nat. of Effluv. Chap. 4.

(iii) There are many Stories told of the Craft of the Fox, to compass his Prey; of which Ol, Magnus hath many such, as feigning the Barking of a Dog, to catch Prey near Houses; feigning himself dead, to catch such Animals as come to feed upon him; laying his Tail on a Wasp-Nest, and then rubbitte it hard against a Tree, and then eating the Wasps so killed : Ridding himself of Fleas, by gradually going into Water, with a Lock of Wool in his Mouth, and fo driving the Fleas up into it, and then leaving it in the Water: By catching Crab-Fish with his Tail, which he saith he himself was an Eye-witness of; Vidi & ego in Scopulis Norvegia Vulpem, interrupes immissa cauda in aquas, plures educere Cancros, ac demum devorare.

Ol. Mag. Hift. 1. 18. c. 39, 40.

But Pliny's fabulous Story of the Hyana out-does these Relations of the Fox. Sermonem humanum inter pafforum stabula affimulare, nomenque alicujus addiscere, quem evocatum foràs laceret, Item Vomitionem hominis imitari ad follicitandos Ganes quos invadat. Plin.

Nat. Hift. 1. 8, c. 30.

(kkk) This do Ducks, Woodcocks, and many other Fowls, which feek their Food in dirty, moorish Places. For which Service. they have very remarkable Nerves reaching to the End of their Bills, Of which fee Book VII, Chap. 2. Note (e). (III) Swine 210 Of Animals Sagacity BOOK IV.

and delve for it, both above (111), and under the Surface of the drier Lands (mmm)! And how curious and well defigned a Provision is it of particular large Nerves in such Creatures, adapted to

that especial Service!

What an admirable Faculty is that of many Animals, to discover their Prey at vast Distances; some by their Smell some Miles off (nnn); and some by their sharp and piercing Sight, alost in the Air, or at other great Distances (000)! An Instance of the latter of which God himself giveth, [70b xxxix. 27, 28, 29.] in the Instinct of the Eagle: Doth the Eagle mount up at thy Command, and make her Nest on high? She dwelleth

(III) Swine, and other Animals that dig, have their Noses made more tendinous, callous, and strong for this Service, than others that do not dig. They are also edged with a proper, tough Border, for penetrating and lifting up the Earth; and their Nostrils are placed well, and their Smell is very accurate, to discover whatsoever they pursue by Digging.

(mmm) The Mole, as its Habitation is different from that of other Animals, so hath its Organs in every Respect curiously adapted to that way of Life; particularly its Nose made sharp, and slender, but withal tendinous and strong, &c. But what is very Remarkable, it hath such Nerves reaching to the End of its Nose and Lips, as Ducks, &c. have, mentioned above in Note (kkk). Which Pair of Nerves I observed to be much larger in this Animal than any other Nerves proceeding out of its Brain.

(mm) Predacious Creatures, as Wolfs, Foxes, &c. will discover Prey at great Distances; so will Dogs and Ravens discover Carrion a great Way off by their Smell. And if (as the Superstitious imagine) the latter flying over and haunting Houses be a Sign of Death, it is no doubt from some cadaverous Smell, those Ravens discover in the Air by their accurate Smell, which is emitted from those diseased Bodies, which have in them the Principles of a speedy Death.

(000] Thus Hawks and Kites on Land, and Gulls, and other Birds, that prey upon the Waters, can at a great Height in

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leth and abideth on the Rock, upon the Crag of the Rock, and the strong Place (ppp). From thence she seeketh her Prey, and her Eyes behold afar off. What a commodious Provision hath the Contriver of Nature made for Animals, that are necessitated to climb for their Food; not only in the Structure of their Legs and Feet, and in the Strength of their Tendons and Muscles, acting in that particular Office (qqq); but also in the peculiar Structure of the principal Parts, acting in the Acquest of their Food (rrr)! What a Provision also

the Air see Mice, little Birds and Insects on the Earth, and small Fishes, Shrimps, &c. in the Waters, which they will

dart down upon, and take.

(ppp) Mr. Ray gives a good Account of the Nidification of the Chrysaëtos cauda annulo albo cineta. Hujus Nidus Ann. 1668. in sylvosis prope Derwentiam, &c. inventus est è bacillis seu virgis ligneis grandioribus compositus, quorum altera extremitas rupis cujusdam eminentia, altera duabus Betulis innitebatur, - Erat Nidus quadratus, duas ulnus latus. - In eo pullus unicus, adjacentibus cadaveribus unius agni, unius leporis, & trium Grygallorum pullorum. Synopf. Method. Avium, p. 6. And not only Lambs, Hares, and Grygalli, but Sir Robert Sibbald tells us, they will feize Kids and Faruns; yea, and Children too: Of which he hath this Story of an Eagle in one of the Orcades Islands. Qua Infantulum unius anni pannis involutum arripuit (quem Mater tessellas usibiles pro igne allatura momento temporis deposuerat in loco Houton-Hed dicto) eumque deportasse per a milliaria passum ad Hojam; qua re ex matris ejulatibus sognita, quatuor viri illuc in navicula profecti sunt, & scientes ubi Nidus esset, infantulum illasum & intastum deprehenderunt. Prod. Nat. Hift. Scot. 1. 3. part. 2. p. 14.

(999) See in Book VII. Chap. 1. Note (1). the Characterif-

ticks of the Wocdpecker-kind.

(rr) The Contrivance of the Legs, Feet, and Nails [of the Oposfum] seems very advantagious to this Animal inclimbing Trees (which it doth very nimbly) for preying upon Birds. But that is most fingular in this Animal, is the Structure of its Tail, to enable it to hang on Boughs. The Spines, or Hooks—in the middle of the under Side of the Vertebræ of the Tail, are a wonderful Piece of Nature's Mechanism. The first three Vertebræ had none of these P & Spinesa also is that in nocturnal Birds and Beasts, in the peculiar Structure of their Eye (sss), (and we may perhaps add the Accuracy of their Smell too) whereby they are enabled to discover their Food in the Dark? But among all the Instances we have of natural Instinct, those Instincts, and especial Provisions made to supply the Necessities of Helpless Animals, do in a particular Manner demonstrate the Great Creator's Care. Of which I shall give two Instances.

1. The Provision made for young Creatures. That Erozyi, that natural Affection, so connatural to all, or most Creatures towards their Young (ttt), what an admirable noble Principle is it, implant-

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(sss) See before Chap. 2. Note (2), (an), (bb).

To this natural Care of Parent-Animals to their young, we may add the Returns made by the young of fome towards the old ones. Pliny faith of Rats, Genitores fisos fessos fenecta, alunt insigni pietate. Nat. Hist. I. S. c. 57. So Cranes, he faith, Gen-

tricum senectam invicem educant. L. 10. c. 23.

for th Fowl with will c Dista Youn fecuri to thi Skele lie th

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Spines, but in all the rest they were to be observed .-They were placed just at the Articulation of each Joynt, and in the Middle from the Sides .- For the performing this Office [of hanging by the Tail] nothing. I think, could be more advantagiously contrived. Tail is twirled or wound about a Stick, this Hook of the Spina easily sustains the Weight, and there is but little Labour of the Muscles required, only enough for bowing or crooking the Tail. This, and more to the same Purpose, see in Dr. Tyson's Anatomy of the Opossum, in Philosophical Transact. No. 239.

⁽ttt) Quid dicam quantus amor bestiarum sit in educandis custodiendisque iis, que procreaverint, usque ad eum finem, dum posint seipsa defendere? And having instanced in some Animals, where this Care is not necessary, and accordingly is not employed, he goes on, Fam Gallina, avefque reliqua, & quietum requirunt al pariendum locum, & cubilia sibi, nidosque construunt, eosque quam pofsunt mollissime substernunt, ut quam facillime ova serventur. Exquibu pullos cum excluserint, ita tuentur, ut & pennis foveant, ne frigon ladantur, & fi eft calor, à sole se opponant. Cic. de Nat. Deor. l. 2. C. 51, 52.

ed in them by the Wise Creator? By Means of which, with what Alacrity do they transact their parental Ministry? With what Care do they nurse up their Young; think no Pains too great to be taken for them, no Dangers (uuu) too great to be ventured upon for their Guard and Security? How carefully will they lead them about in Places of Sasety, carry them into Places of Retreat and Security; yea, some of them admit them into their own Bowels (www)? How will they ca-

This St. Ambrose takes Notice of in his Hexameron, and Ol. Magnus after him, Depositi patris artus, per longavum senettutis plumis nudatos circumstans soboles pennis propriis sovet, — collatitio cibo puscit, quando etiam ipsa natura reparat dispendia, ut hinc inde senem sublevantes, sulcro alarum suarum ad volandum exerceant, & in pristinos usus desueta membra reducant. For which Reason this Bird is denominated Pia. Vid. Ol. Mag. Hist. 1. 19. c. 14.

Hereto may be added also the conjugal Erogy) of the little green Æthiopian Parrot, which Mr. Ray describes from Clusius. Famellea senescentes (quod valde notabile) vix edere volebant, nist cibum jam à mare carptum, & aliquandiu in prolobo retentum, & quasi coctum rostro suo exciperent, ut Columbarum pulli à matre ali solent.

Synops. Meth. Av. p. 32.

(uuu) The most timid Animals, that at other Times abfood, or hastily fly from the Face of Man, Dogs, &c. will, for the sake of their Young, expose themselves. Thus among Fowls, Hens will affault, instead of fly from such as meddle with their Brood. So Partridges, before their Young can fly, will drop frequently down, first at lesser, and then at greater Distances, to dodge and draw off Dogs from pursuing their Young.

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(www) The Opossum hath a curious Bag on purpose for the securing and carrying about her Young. There are belonging to this Bag two Bones (not to be met with in any other Skeleton) and sour Pair of Muscles, and some say the Teats lie therein also. Dr. Tyson, Anat. of the Oposs. in Phil. Trans. No. 239. where he also, from Oppian, mentions the Dog-Fish, that upon any Storm or Danger, receives the young Ones into her Belly, which come out again when the Fright is over. So also the Squatina and Glaucus, the same Author

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ress them with their affectionate Notes, sull and quiet them with their tender parental Voice, put Food into their Mouths, suckle them, cherish and keep them warm, teach them to pick, and eat, and gather Food for themselves; and, in a Word, perform the whole Part of so many Nurses, deputed by the Sovereign Lord and Preserver of the World, to help such young and shiftless Creatures, till they are come to that Maturity, as to be able to shift for themselves?

And as for other Animals (particularly Infects, whose Sire is partly the Sun, and whose numerous Off-fpring would be too great for their Parent-Animal's Care and Provision) these are so generated, as to need none of their Care, by Reason they arrive immediately to their 'HAIRIG, their perfect, adult State, and are able to shift for themselves. But yet, thus far their parental Instinct (equivalent to the most rational Care and Foresight) doth extend, that the old Ones do not wildly drop their Eggs and Sperm any where, at all Adventures, but so cautiously reposit it in such commodious Places (some in the Waters, some on Flesh, some on Plants, proper and agreeable to their Species (xxx); and some shut up agreeable Food in their Nests, partly for Incubation, partly for Food (yyy), that their Young in their Aurelia, or Nympha State, may find fufficient and agreeable Food to bring them up, till they arrive to their Maturity.

Thus far the Parental Instinct and Care.

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faith, have the fame Care for their Young, but receive them into different Receptacles.

⁽xxx) See Book VIII. Chap. 6. (yyy) See Chap. 13. Note (1).

⁽zzz) There

Next we may observe no less in the young themselves, especially in those of the irrational Animals. Forasmuch as the Parent-Animal is not able to bear them about, to cloath them, and to dandle them, as Man doth; how admirably hath the Creator contrived their State, that those poor young Creatures can soon walk about, and with the little Helps of their Dam, shift for, and help themselves? How naturally do they hunt for their Teat, suck, pick (zzz), and take in their proper Food?

But for the Young of Man, their Parents Reafon, joined with natural Affection, being sufficient to help, to nurse, to feed, and to cloath them; therefore they are born helpless, and are more absolutely, than other Creatures, cast upon their Parents Care (aaaa). A manifest Act and Designation of the Divine Providence.

2. The other Instance I promised, is the Provifion made for the Preservation of such Animals as are sometimes destitute of Food, or in Danger of being so. The Winter is a very inconvenient, improper

(aaaa) Qui [Infantes] de ope nostra ac de divina misericordia plus merentur, qui in primo statim nativitatis sua ortu plorantes ac flentes, nil aliud faciunt quam deprecantur. Cypr. Ep. ad Fid.

⁽²²²⁾ There is manifestly a Superintending Providence in this Case, that some Animals are able to suck as soon as ever they are born, and that they will naturally hunt for the Teat before they are quite gotten out of the Secundines, and parted from the Navel-String, as I have seen. But for Chickens, and other young Birds, they not being able immediately to pick till they are stronger, have a notable Provision made for such a Time, by a part of the Yolk of the Egg being inclosed in their Belly, a little before their Exclusion or Hatching, which serves for their Nourishment, till they are grown strong enough to pick up Meat. Vid. Book VII. Chap. 4. Note (a).

proper Season, to afford either Food or Exercise to Infects, and many other Animals. When the flowry Fields are divested of their Gaiety; when the fertile Trees and Plants are fripp'd of their Fruits, and the Air, instead of being warmed with the cherishing Beams of the Sun, is chilled with rigid Frost; What would become of such Animals as are impatient of Cold? What Food could be found by fuch as are subsisted by the Summer-Fruits? But to obviate all this Evil, to stave off the Destruction and Extirpation of divers Species of Animals, the Infinitely Wife Preserver of the World hath as wisely ordered the Matter; that, in the first Place, fuch as are impatient of Cold, should have such a special Structure of their Body, particularly of their Hearts, and Circulation of their Blood (bbbb), as during that Season, not to suffer any waste of their Body, and consequently not to need any Recruits; but that they should be able to live in a kind of fleepy, middle State, in their Places of fafe Retreat, until the warm Sun revives both them and their Food together.

The next Provision is for such as can bear the Cold, but would want Food then; and that is in some by a long Patience of Hunger (cccc), in others

(bbbb) I might name here some of the Species of Birds, the whole Tribe almost of Insects, and some among other Tribes, that are able to subsist for many Mouths without Food, and some without Respiration too, or very little: But it may suffice to instance only in the Land-Tortoise, of the Structure of whose Heart and Lungs, See Book VI. Chap. Note (b).

(cecc) Înediam distissime tolerat Lupus, ut & alia omnia carnivora, ticet voracissima; magna utique nature providentia; quoniam esca non semper in promptu est. Ray's Synops. Quadr. p. 174.

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13. Note As fo VIII, C by their notable Instinct in laying up Food beforehand against the approaching Winter (dddd.) Of this many entertaining Examples may be given; particularly we may, at the proper Season, observe not only the little Treasures and Holes well-stocked with timely Provisions, but large Fields (eeee)

here

To the long Abstinence mentioned of Brute Animals, I hope the Reader will excuse me, if I add one or two Instances of extraordinary Abstinence among Men. One Martha Taylor, born in Derbyspire, by a Blow on the Back fell into such a Profration of Appetite, that she took little Sustenance, but fome Drops with a Feather, from Christmas 1667, for thirteen Months, and flept but little too all the Time. See Dr. Sampson's Account thereof in Ephem. Germ. T. 3. Obs. 173.

To this we may add the Case of S. Chilton, of Tinsbury, near Bath, who in the Years 1693, 1696, and 1697, flept divers Weeks together. And although he would fometimes, in a very odd manner, take Sustenance, yet would lie a long Time without any, or with very little, and all without any

confiderable Decay. See Phil. Trans. No. 304.
(dddd) They are admirable Instincts which the Sieur de Beauplau relates of his own Knowledge, of the little Animals called Bohaques in Ukraine, They made Burroughs like Rabbets. and in October fout themselves up, and do not come out again till April. They spend all the Winter under Ground, eating what they laid up in Summer .- Those that are lazy among them, they lay on their Backs, then lay a great handful of dry Herbage upon their Bodies. &c. then others drag those Drones to the Mouths of their Burroughs, and so those Creatures serve instead of Barrows, &c. I have often seen them practife this, and have had the Curiofity to observe them whole Days together. ___ Their Holes are parted like Chambers ; some serve for Store-Houses, others for Burying-Places, &c. Their Government is nothing inserior to that of Bees, &c. They never go abroad without posting a Centinel upon some high Ground, to give notice to the others whilft they are feeding. As soon as the Centinel sees any Body, it stands upon his Hind-Legs and whiftles. Beauplau's Description of Ukraine. in Vol. I. of the Collection of Voyages, &c.

A like Instance of the Northern Galli Sylvestres, see in Chap.

13. Note (g).

As for the Scriptural Instance of the Ant, see hereafter Book VIII, Chap. 5. Note (d).

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here and there throughout bespread with considerable Numbers of the Fruits of the neighbouring Trees, laid carefully up in the Earth, and covered safe, by the provident little Animals inhabiting thereabouts. And not without Pleasure have I seen and admired the Sagacity of other Animals, hunting out those subterraneous Fruits, and pillaging the Treasures of those little provident Creatures.

And now from this bare transfent View of this Branch of the Great Creator's Providence and Government, relating to the Food of his Creatures, we can conclude no less, than that since this Grand Affair hath fuch manifest Strokes of admirable and wife Management, that fince this is demonstrated throughout all Ages and Places, that therefore it is God's Handy-Work. For how is it possible that fo vast a World of Animals should be supported, fuch a great Variety equally and well supplied with proper Food, in every Place fit for Habitation, without an especial Superintendency and Management, equal to, at least, that of the most prudent Steward and Housholder? How should the Creatures be able to find out their Food when laid up in fecret Places? And how should they be able to gather even a great deal of the common Food, and

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⁽eeee) I have in Autumn, not without Pleasure observed not only the great Sagacity and Diligence of Swine, in hunting out the Stores of the Field Mice; but the wonderful Precaution also of those little Animals, in hiding their Food beforehand against Winter. In the Time of Acorns falling, I have, by means of the Hogs, discovered, that the Mice had, all over the neighbouring Fields, treasured up fingle Acorns in little Holes they had scratched, and in which they had carefully covered up the Acorn. These the Hogs would, Day after Day, hunt out by their Smell.

at last to macerate and digest it, without peculiar Organs adapted to the Service? And what less than an Infinitely Wife God could form such a Set of curious Organs, as we find every Species endowed with, for this very Use? Organs so artificially made, fo exquisitely fitted up, that the more strictly we furvey them, the more accurately we view them (even the meanest of them with our best Glasses) the less Fault we find in them, and the more we admire them: Whereas the best polished, and most exquisite Works, made by Human Art, appear thro' our Glasses, as rude and bungling, deformed and monstrous; and yet we admire them, and call them Works of Art and Reason. And lastly, What less than Rational and Wife could endow irrational Animals with various Instincts, equivalent, in their special Way, to Reason it self? Insomuch that some from thence have absolutely concluded, that those Creatures had some Glimmerings of Reason. But it is manifestly Instinct, not Reason they act by, because we find no varying, but that every Species doth naturally purfue at all Times the same Methods and Way, without any Tutorage or Learning: Whereas Reason, without Instruction, would often vary, and do that by many Methods, which Instinct doth by one alone. But of this more hereafter.

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CHAP. XII. Of the Cloathing of Animals.

HAving in the foregoing Chapter, somewhat largely taken a View of the Infinite Creator's Wisdom and Goodness toward his Creatures,

Of Animals Cloathing. BOOK IV.

in ordering their Food, I shall be more brief in this Chapter, in my View of their Cloat bing (a); another necessary Appendage of Life, and in which we have plain Tokens of the Creator's Art, manifested in these two Particulars; the Suitableness of Animals Cloathing to their Place and Occasions; and the Garniture and Beauty

thereof.

I. The Cloathing of Animals is fuited to their Place of Abode, and Occasions there; a manifest Act of Design and Skill. For if there was a Possibility, that Animals could have been accoutred any other Way, than by God that made them, it must needs have come to pass, that their Cloathing would have been at all Adventures, or all madethe same Mode and Way, or some of it, at least, inconvenient and unfuitable. But on the contrary, we find all is curious and compleat, nothing too much, nothing too little, nothing bungling, nothing but what will bear the Scrutiny of the most exquifite Artist; yea, and so far out-do his best Skill, that his most exquisite Imitations, even of the meanest Hair, Feather, Scale, or Shell, will be found only as so many ugly, ill-made Blunders and Botches, when strictly brought to the Test of good Glasses. But we shall find an Example remarkable enough in the present Case, if we only compare the best of Cloathing which Man makes for himself, with that given by the Creator for the Covering of

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⁽a) Concerning the Cleathing of Animals, Ariffotle observes, That such Animals have Hair as go on Feet, and are viviparous; and that such are covered with a Shell, as go on Feet, and are oviparous. Hist. Anim. 1. 3. c. 10. (6) Cujus

CHAP. XII. Of Animals Cloathing. 221

the irrational Creatures. Of which it may be faid, as our Saviour doth of the Flowers of the Field, Matt. vi. 29. That even Solomon, in all his

Glory, was not arrayed like one of thefe.

But let us come to Particulars, and consider the Suitableness of the different Methods the Creator hath taken in the Cloathing of Man, and of the irrational Animals. This Pliny (b) pathetically laments, and says, It is hard to judge, whether Nature bath been a kinder Parent, or more cruel Step-Mother to Man. For, says he, Of all Creatures, he alone is covered with other's Riches, whereas Nature hath given various Cloathing to other Animals, Shells, Hides, Prickles, Shag, Bristles, Hair, Down, Quills, Scales, Fleeces; and Trees she hath fenced with a Bark or two against the Injuries of Cold and Heat. Only poor naked Man, says he, is in the Day of his Birth cast into the wide World, to

Let Seneca answer this Complaint of Pliny, although perhaps what he saith might be more properly noted in another Place: Quisquis es iniquis aftimator sortis humana, cogita quanta nobis tribuerit Parens noster, quanto valenticra animalia sub jugum miserimus, quanto velociora assequamur, quam nihil sit mortale non sub istu nostro positum. Tot virtutes accepimus, tot artes, animum denique cui nihil non eodem quo intendit momento pervium est, Sideribus

velociorem, &c. Senec. de Benef. 1. 2. c. 29.

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⁽b) Cujus [Hominis] causa videtur cuntta alia genuisse Natura, magna & seva mercede contra tanta sua munera: ut non sit satis estimare, Parens melior homini, an tristior Noverca suerit. Ante omnia unum Animantium cunttorum alienis velat opibus: cateris variè tegumenta tribuit, testas, cortices, coria, spinas, villos, setas, pilos, plumam, pennas, squamas, vellera. Truncos etiam arboresque cortice, interdum gemino, à frigoribus, & calore tutata est. Hominem tantum nudum, & in nuda humo, natali die abjicit ad vagitus statim & ploratum, nullumque tot animalium aliud ad lacrymas, & has protinus vita principio. Plin. Nat. Hist. 1. 7. Procem.

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immediate crying and squalling; and none of all Creatures besides, so soon to Tears in the very

beginning of their Life.

But here we have a manifest Demonstration of the Care and Wisdom of God towards his Creatures; that such should come into the World with their Bodies ready surnished and accommodated, who had neither Reason nor Forecast to contrive, nor Parts adapted to the Artistices and Workmanship of Cloathing; but for Man, he being endowed with the transcending Faculty of Reason, and thereby made able to help himself, by having Thoughts to contrive, and withal Hands to essentiate the skins of the skins of the care and sufficient Materials (c) afforded him from the Skins

(c) Mirantur plurimi quomodo tute, & sane vivant homines in horrendis frigoribus plaga Sepentrionalis; hancque levem quastionem ulva 30 annos audieram in Italia, prasertim ab Æthiopibus, & Indis, quibus onerosus videtur vestitus sub Zona torrida. — Quibus respondetur, — Gaudet Indus multiplici plumarum genere, magis forsan pro tegumento, quàm necessitate: rursus Scytha villoso vestitu. — Ita sub pole Arctico adversus asperrimas hyemes — opportuna remedia faciliter administrat [Natura,] Ligna videlicet in maxima copia, & levissimo pretio, & demum Pelles diversorum animalium, tam sylvestrium quàm domesticorum. Then he gives a Catalogue of them, and saith, Quarum omnium experti pellistices ita ingeniose noverunt mixturas componere, ut pulcherrimum decorem ostendat varietas, & salidissimum somentum adjuncta mollities. Ol. Mag. Hist. 1. 6. c. 20.

To this Guard against the Cold, namely, of Fire and Cloathing; I hope the Reader will excuse me, if I take this Opportunity of adding some other Desensatives Nature, (or rather the Great Author of Nature,) hath afforded these Northern Regions: Such are their high Mountains, abounding, as Ol. Magnus saith, through all Parts; also, their numerous Woods, which besides their Fire, do, with the Mountains, serve as excellent Screens against the Cold, piercing Air, and Winds. Their prodigious Quantities of Minerals, and Metals also afford Heat, and warm Vapours, Minera septentrionalium regionum satis multa, magna, diversa, & opulenta sunt, saith the same curious, and (for his Time,) learned Archbishop.

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CHAP. XII. Of Animals Cloathing. 223
Skins and Fleeces of Animals, and from various
Trees and Plants: Man, I say, having all this
Provision made for him, therefore the Creator
hath wisely made him naked, and left him to
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1. 6. c. 1. and in other Places. And for the Warmth they afford, the Vulcano's of those Parts are an Evidence; as are also their terrible Thunder and Lightning, which are observ'd to be the most severe and mischievous in their metalline Mountains, in which large Herds of Cattle are sometimes destroy'd: the Rocks so rent and shattered, that new Veins of Silver are thereby discover'd; and a troublesome Kind of Quinsie is produc'd in their Throats, by the Stench, and poissonous Nature of the sulphureous Vapours, which they dissolve, by drinking warm Beer and Butter together, as Olaus tells us in

the fame Book, Chap. 11.

To all which Defensatives, I shall, in the last Place add. the warm Vapours of their Lakes, (some of which are prodigiously large, of 130 Italian Miles in Length, and not much less in Breadth;) also of their Rivers, especially the Vapours which arise from the Sea. Of which Guard against severe Cold, we have lately had a convincing Proof in the Great Froft, in 1708, wherein, when England, Germany, France, Denmark; yea, the more southerly Regions of Italy, Switzerland, and other Parts, suffer'd severely; Ireland and Scotland selt very little of it, hardly more than in other Winters; of the Particulars of which, having given an Account in the Philof. Trans. No. 324. I shall thither refer the Reader. But it feems, this is what doth ordinarily befal those Northern Parts; particularly the Mands of Orkney, of which the learned Dr. Wallace gives this Account : Here the Winters are generally more Subject to Rain than Snow; nor doth the Frost and Snow continue so long here, as in other Parts of Scotland; but the Wind in the mean Time will often blow very boisterously; and it Rains sometimes, not by Drops, but by Spouts of Water, as if whole Clouds fell down at once. In the Year 1680, in the Month of June, after great Thunder, there fell Flakes of Ice near a Foot thick. Wall. Account of Orkney, ch. 1. 7. 4. From which last Passage I observe; That although in those Parts, the Atmosphere near the Earth be warm, it is exceffively Cold above; fo as to freeze some of those Spouts of Water in their Descent, into such great, and almost incredible Masses of Hail. And whence can this Warmth proceed, but from the Earth, or Sea, emitting Heat fufficient to ttave off the Cold above? Confult Book II. Chap. 5. Note (c).

(d) Sicut

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shift for himself, being so well able to help himself. And a notable Act this is of the Wisdom of GOD, not only as the more setting forth his Care and Kindness to them that most needed his Help, the helpless irrational Animals, and in his not overdoing his Work; but also as it is most agreeable to the Nature and State of Man (d), both on natural and political Accounts. That Man should cloath himself, is most agreeable to his Nature, particularly (among other Things,) as being most salutary, and most suitable to his Affairs. For by this Means, Man can adapt his Cloathing to all Seasons, to all Climates, to this, or to any Business. He can hereby keep himself sweet and clean, sence off many Injuries; but above all, by this Method of Cloathing, with the natural Texture of his Skin adapted to it, it is that grand Means of Health, namely, infenfible Perspiration (e) is perform'd, at least greatly promoted,

(d) Sicut enim si innata sibi [i. e. Homini] aliqua haberet arma, illa ei sola semper adessent, ita & si artem aliquam Natura sertitus esset, reliquas sanè non haberet. Quia verò ei melius erat omnibus armis, omnibusque artibus uti, neutrum eorum à naturh ipsi proptered datum est. Galen. de Us. Part. l. 1. c. 4.

And as to the wonderful Benefits of insensible Perspiration, they are abundantly demonstrated by the same learned Per-

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⁽e) Concerning insensible Perspiration, Santforius observes, That it much exceeds all the Sensible put together. De Stat. Med. Aph. 4. That as much is evacuated by insensible Perspiration in one Day, as is by Stool in sourteen Days. Particularly, That, in a Night's Time, about fixteen Ounces is commonly sent out by Urine, sour Ounces by Stool; but above forty Ounces by insensible Perspiration. Apor. 59, 60. That if a Man eats and drinks eight Pounds in a Day, sive Pounds of it is spent in insensible Perspiration, Sect. 1. Aph. 6. And as to the Times, he saith, Ab assumpto ciho 5 horis 1 l. circiter perspirabilis—exhalare solet, à 5a ad 12am 3 l. circiter; à 12a ad 16am vix selibram. Aph. 56.

CHAP. XII. Of Animals Cloathing. 225 moted, without which an Human Body would be foon over-run with Difeafe.

In the next Place, there are good political Reafon's for Man's cloathing himself, inasmuch as his Industry is hereby employed in the Exercises of his Art and Ingenuity; his Diligence and Care are exerted in keeping himself, sweet, cleanly, and neat; many Callings and Ways of Life arise from thence, and, (to name no more,) the Ranks and Degrees of Men are hereby in some Measure rendered visible to others, in the several Nations of the Earth.

Thus it is manifestly best for Man that he should

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But for the poor shiftles Irrationals, it is a prodigious Act of the great Creator's Indulgence, that they are all ready furnished with such Cloathing, as is proper to their Place and Business (f). Some covered with Hair (g), some with Feathers

son, ubi supra; as also by Boreli in his second Part, De Mot. Animal. Prop. 168. who saith, Necessaria est insensibilis Transpiratio, ut vita Animalis conservetur.

(f) Animantium verò quanta varietas est? Quanta ad eam rem vis, ut in suo quaque genere permaneant? Quarum alia coriis tecta sunt, alia villis vestita, alia spivis birsuta: pluma alias, alias squama videmus obductas, alias esse cornibus armatas, alias habere essugia pen-

narum. Cic. de Nat. Deor. 1. 2. c. 47.

(2) From Malpighi's curious Observations of the Hair, I shall note three Things. 1. Their Structure is sistuous, or tubular; which hath long been a Doubt among the curious. Fistulosum [esse Pilum] demonstrant lustratio pilorum à caudê & collo Equorum, & precipue setarum Apri, que patentiorem ex sistulis compositionem exhibent. Est autem dictus Apripilus Cylindricum corpus quast diaphanum—fistularum aggere constatum, & speciem columna striata pra se fert. Componentes sistula in gyrum situata in apice patentiores redduntur; nam hians pilus in geminas dividitur partes, & componentes minima sistula—liberiores reddita manisestantur, ita ut enumerati possunt; has autem 20, & ultra numeravi.

Of Animal's Cloathing. BOOK IV.

thers (b), some with Scales, some with Shells (i), fome only Skin, and some with firm and stout Armature; all nicely accommodated to the Element in which the Creature liveth, and its Occasions there (k). To Quadrupeds Hair is a commodious Cloath.

Exposita fistula-tubulosa sunt, & frequentibus tunicis trans. versaliter situatis, veluti valvulis pollent. Et quoniam Spina, in Erinaceis pracipui, &c. nil aliud funt, quam duri & wigidi pili, ides, &c. And then he describes the Hedgehog's Spines, in which those Tubes manifestly appear; together, with medullary Valves and Cells; not inelegant, which he hath figur'd in

Tab. 16, at the End of his Works.

That which this fagacious, and not enough to be commended Observer, took notice of in the Structure of Hair, and its Parity to the Spines; I have my felf observ'd in some Measure to be true, in the Hair of Cats, Rats, Mice, and divers other Animals; which look very prettily when view'd with a good Microscope. The Hair of a Monfe, (the most transparent of any I have view'd,) seems to be one single transparent Tube, with a Pith made up of a fibrous Substance, running in dark Lines; in some Hairs transversly, in others spirally, as in Fig. 14, 15, 16, 17. These darker medullary Parts, or Lines, I have observed, are no other than fmall Fibres convolved round, and lying closer together than in other Parts of the Hair. They run from the Bottom, to the Top of the Hair; and I imagine, ferve to the gentle Evacuation of fome Humour out of the Body; perhaps, the Hair serves as well for the insensible Perspiration of hairy Animals, as to fence against Cold and Wet. In Fig. 14, 16. is represented the Hair of a Mouse, as it appears through a small Magnifier; and in Fig. 15, 17. as it appears when view'd with a larger Magnifier.

Upon another Review, I imagine, That although in Fig. 14. 15. the dark Parts of the Pith feem to be transverse; that they, as well as in the two other Figures, run round in a

fcrew-like Fashion.

(h) See Book VII. Chap. I. Note (d), (e).

(i) See Chap. 14. Note (c).

(k) It is a Sign some wife Artist was a Contriver of the Cloathing of Animals; not only as their Cloathing varies, as their Way of Living doth; but also because every Part of their Bodies is furnished with proper suitable Cloathing.

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CHAP. XII. Of Animals Cloathing. 227

ing; which, together with the apt Texture of their Skin, fitteth them for all Weathers, to lie on the Ground, and to do the Offices of Man; and the thick and warm Furs and Fleeces of others, are not only a good Detensative against the Cold and Wef; but also a soft Bed to repose themselves in; and to many of them, a comfortable covering, to nurse

and cherish their tender Young.

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And as Hair to Quadrupeds; so Feathers are as commodious a Dress to such as fly in the Air; to Birds, and some Insects; not only a good Guard against Wet and Cold, and a comfortable Covering to such as hatch and brood their Young; but also most commodious for their Flight. To which Purpose they are nicely and neatly placed every where on the Body, to give them an easy Passage through the Air (1), and to assist in the wasting their Body through that thin Medium. For which Service, how curious is their Texture for Lightness, and withal for Strength? Hollow and thin tor Lightness, but withal, context and firm for Strength.

Thus divers Animals, that have their Bodies covered for the most Part with short, smooth Hair, have some Parts lest nated, where Hair would be an Annoyance: And some Parts beset with long Hair; as their Mane and Tail: And some with siff, strong Bristles; as about the Nose: And sometimes within the Nostrils, to guard off, or give warning of Annoyances.

(1) The Feathers being placed from the Head towards the Tail, in close and neat Order, and withat preened and drefted by the Contents of the Oil-Bag, afford as easy a Passage brough the Air, as a Boat new cleaned and dressed finds in its Passage through the Waters. Whereas, were the Feathers placed the contrary, or any other Way (as they would have been, had they been placed by Chance, or without Art) they would then have gathered Air, and been a great Encumbrance to the Passage of the Body through the Air. See Book VII, Chap. 1. Note (b).

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Strength. And where it is necessary they should be filled, what a light and strong, medullary Substance is it they are filled with? By which curious Contrivances, even the very heaviest Parts made for Strength, are so far from being a Load to the Body. that they rather affift in making it light and buoy. ant, and capacitate it for Flight. But for the Vanes, the lightest Part of the Feather, how curiously are they wrought with capillary Filaments, neatly interwoven together (m), whereby they are not only light, but also sufficiently close and strong, to keep the Body warm, and guard it against the Injuries of Weather, and withal, to impower the Wings, like so many Sails, to make strong Impulses upon the Air in their Flight (n). Thus curious, thus artifcial, thus commodious is the Cloathing of Beafts and Birds: Concerning which, more in proper Place.

And no less might I shew that of Reptiles and Fishes (0) to be, if it was convenient to enlarge upon this Branch of the Creator's Works. How well adapted are the *Annuli* of some Reptiles, and the Contortions of the Skin of others, not only to sence the Body sufficiently against outward Injuries; but to enable them to creep, to perforate the Earth (p)

(m) In Book VII. Chap. 1. Note (e), there is a particular Account of the Mechanism of their Vanes, from some nice Microscopical Observations, and therefore I shall take no farther Notice of it here.

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⁽n) Vide Borell. de Mot. Animal. Prop. 182. Vol. I.

⁽o) See Book IX.

(p) For a Sample of this Branch of my Survey, let us chuft the Tegument of Earth-Worms, which we shall find compleatly adapted to their Way of Life and Motion, being made in the most compleat Manner possible for terebrating the Earth.

CHAP. XII. Of Animals Cloathing. 229

and in a Word, to perform all the Offices of their Reptile State, much better than any other Tegument of the Body would do? And the same might be said of the Covering of the Inhabitants of the Waters, particularly the Shells of some, which are a strong Guard to the tender Body that is within, and consistent enough with their slower Motion; and the Scales and Skins of others, affording them an easy and swift Passage through the Waters. But it may be sufficient to give only a Hint of these Things, which more properly belong to another Place.

Thus hath the Indulgent Creator finished the whole Animal World with convenient, suitable Cloathing.

II. Let us, in the next Place, take a short View of the Garniture (q), and Beauty thereof. And here we shall thus far, at least, descry it to be beautiful; that it is Compleat and Workman-like.

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(q) Aristotle, in his Hist. Anim. 1, 3. c. 12. names several Rivers, that by being drank of, change the Colour of the Hair.

and creeping where their Occasions lead them. For their Body is made throughout of small Rings, and these Rings have a curious Apparatus of Muscles, enabling those Creatures with great Strength to dilate, extend, or contract their Annuli, and whole Body; those Annuli also are each of them armed with small, stiff, sharp Beards, or Prickles, which they can open, to lay hold on, or shut up close to their Body: And lastly, Under the Skin there lies a slimy Juice, that they emit, as Occasion is, at certain Perforations between the Annuli, to lubricate the Body, and facilitate their Passage into the Earth. By all which Means they are enabled with great Speed, Eafe, and Safety, to thrust and wedge themselves into the Earth; which they could not do, had their Bodies been covered with Hair, Feathers, Scales, or fuch like Cloathing of the other Creatures. See more concerning this Animal, Book IX. Chap. I. Note (a).

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Even the Cloathing of the most sordid Animals, those that are the least beautified with Colours, or rather whose Cloathing may regrate the Eye (r); yet when we come strictly to View them, and seriously consider the nice Mechanism of one Part, the admirable Texture of another, and the exact Symmetry of the Whole; we discern such Strokes of inimitable Skill, such incomparable Curiosity, that we may say with Solomon Eccl. iii. 11. [God] bath made every Thing beautiful in his Time.

But for a farther Demonstration, of the supereminent Dexterity of his Almighty Hand, he hath been pleased, as it were on Purpose, to give surprizing Beauties to divers Kinds of Animals. What radiant Colours are many of them, particularly some Birds and Insects (s), bedeck'd with! What a prodigious Combination is there often of these, yea, how nice an Air frequently of meaner Colours (t), as to captivate the Eye of all Beholders, and exceed

(4) It would be Endless to enter into the Particulars of the beautiful Birds and Insetts of our European Parts; but especially those inhabiting the Countries between the Tropicks, which are observed as much to exceed our Birds in their Colours, as ours do theirs in their Singing.

(t) The Wryneck, at a Distance, is a Bird of mean Colour; neither are indeed its Colours radiant, or beautiful, fingly confider'd: But when it is in the Hand we see its light and darker Colours so curiously mixed together, as to give the Bird a surprizing Beauty. The same is also observable in many Insects, particularly of the Phalana-Kind.

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⁽r) For an Example; Let us take the Cloathing of the Intoife and Viper; because, by an incurious View, it rather regrateth, than pleaseth the Eye: But yet, by an accurate Survey, we find the Shells of the Former, and the Scales of the Latter, to be a curious Piece of Mechanism, neatly made; and so compleatly, and well put, and tacked together, as to exceed any Human Composures: Of the Latter, see more in Book IX. Chap. 1. Note (c).

CHAP. XIII. Of Animals Habitations, 231 the Dexterity of the most exquisite Pencil to copy?

And now, when we thus find a whole World of Animals, cloathed in the wifest Manner, the most fuitable to the Element in which they live the Place in which they refide, and their State and Occasions there; when those that are able to shift for themselves, are left to their own Discretion and Diligence, but the Helpless well accouter'd and provided for; when such incomparable Strokes of Art and Workmanship appear in all, and such inimitable Glories and Beauties in the Cloathing of others; who can, without the greatest Obstinacy and Prejudice, deny this to be God's Handy-work? The gaudy, or even the meanest Apparel, which Man provideth for himself, we readily enough own to be the Contrivance, the Work of Man: And shall we deny the Cloathing of all the Animal World besides (which infinitely surpasseth all the Robes of earthly Majesty; shall we, dare we, deny that) to be the Work of any Thing less than of an Infinite. Intelligent Being, whose Art and Power are equal to fuch Glorious Work!

CHAP. XIII.

Of the Houses and Habitations of Animals.

HAving in the last Chapter, as briefly, as well I could, furveyed the Cloathing of Animals, I shall in this take a View of their Houses, Nests, their Cells and Habitations; another Thing no less necessary to their Well-being than the last; and in which the Great Creator hath likewise signalized his

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his Care and Skill, by giving Animals an architectonick Faculty, to build themselves convenient Places of Retirement, in which to repose and secure themselves, and to nurse up their Young.

And here, as before, we may confider the Case of Man, and that of the irrational Animals. Man having (as I faid) the Gift of Reason and Understanding, is able to shift for himself, to contrive and build, as his Pleasure leads him, and his Abilities will admit of. From the meanest Huts and Cottages, he can erect himself stately Buildings, bedeck them with exquisite Arts of Architecture, Painting, and other Garniture; ennoble them, and render them delightful with pleasant Gardens, Fountains, Avenues, and what not? For Man therefore the Creator hath abundantly provided in this Respect, by giving him an Ability to Help himself. And a wife Provision this is, inasmuch as it is an excellent Exercise of the Wit, the Ingenuity, the Industry and Care of Man.

But fince Ingenuity, without Materials, would be fruitless, the Materials therefore which the Creator hath provided the World with, for this very Service of Building, deserves our Notice. The great Varieties of Trees (a), Earth, Stones, and

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⁽a) ——Dant utile honum
Navigiis Pinos, domibus Cedrosque, Cupressoque:
Hinc radios trivere Rotis, hinc tympana plaustris
Agricole, & pandas ratibus posuere carinas.
Viminibus Salices foccunda, frondibus Ulmi;
At Myrtus validis hastilibus, & bona bello
Cornus; Ityraos Taxi torquentur in arcus:
Nec Tilia leves, aut torno rasile Buxum,
Non forman accipiunt, ferroque cavantur acuto:
Necnon & torrentem undam levis innatat Alnus

CHAP. XIII. Of Animals Habitations. 233

Plants, answering every Occasion and Purpose of Man for this Use, in all Ages and Places all the World over, is a great Act of the Creator's Goodness; as manifesting, that since he has lest Man to shift for himself, it should not be without sufficient Help to enable him to do so, if he would but make Use of them, and the Sense and Reason which God hath given him.

Thus sufficient Provision is made for the Habita-

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And no less shall we find is made for the rest of the Creatures; who although they want the Power of Reason to vary their Methods, and cannot add to, or diminish from, or any way make Improvements upon their natural Way; yet we find that natural Instinct, which the Creator's Insinite Understanding hath imprinted in them, to be abundantly sufficient, nay, in all Probability, the very best or only Method they can take, or that can be invented for the respective Use and Purpose of each peculiar Species of Animals (b). If some Creatures make their Nests in Houses, some in Trees, some in Shrubs, some in the Earth (c), some in Stone.

Missa Pado: necnon & apes examina condunt Corticibusque cavis, vitiosaque Ilicis alveo.

Virg. Georg. l. 2. carm. 442.

(b) See Chap. 15. and Book VIII. Chap. 6.

⁽c) Many of the Vefpa-Ichneumones are remarkable enough for their Nidification and Provision for their Young. Those that build in Earth (who commonly have golden and black Rings round their Alvi) having lined the little Cells, they have perforated, lay therein their Eggs, and then carry into them Maggots from the Leaves of Trees, and seal them up close and neatly. And another Ichneumon, more of the Vespa than Musca-Ichneumon Kind (having a little Sting in its Tail, of a black Colour) gave me the Pleasure, one Summer, of

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Stone, some in the Waters, some here, and some there, or have none at all; yet we find, that that Place, that Method of Nidification doth abundantly answer the Creatures Use and Occasions. can there fufficiently and well repole, and secure themselves, lay, and breed up their Young. We are so far from discovering any Inconvenience in any of their respective Ways, from perceiving any Loss befal the Species, any Decay, any Perishing of their Young; that in all Probability, on the contrary, in that particular Way they better thrive, are more secure, and better able to shift for, and help themselves. If, for Instance, some Beasts make to themselves no Habitation, but lie abroad in the open Air, and there produce their Young; in this Case we find there is no Need it should be otherwife, by Reason they are either taken Care of by

feeing it build its Nest in a little Hole in my Study-Window. This Cell was coated about with an odoriferous, resinous Gum, collected, I suppose, from some Fir-Trees near; after which it laid two Eggs (I think the Number was) and then carried in divers Maggors, some bigger than it self. These it very sagaciously sealed close up into the Nest, leaving them there doubtless, partly to affist the Incubation; and especially for Food to the suture Young when hatched.

Of this Artifice of these Ichneumons, Aristotle himself takes Notice, (but I believe he was scarce aware of the Eggs sealed up with the Spiders.) Of 3 Eques Iques upones naneurous, &c. As to the Vespæ, called Ichneumones, (less than others) they kill Spiders, and carry them into their Holes, and having sealed them up with Dirt, they therein hatch, and produce those of the same Kind. Hist. Anim. 1. 5. c. 20.

To what hath been faid about these Ichneumon Wasps, I shall add one Observation more, concerning the providential Structure of their Mouth in every of their Tribes, viz. their Jaws are not only very strong, but nicely sized, curved and placed for gnawing and scraping those compleat little Holes they personate in Earth, Wood, yea, in Stone it fels.

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CHAP. XIII. Of Animals Habitations. 235

Man (d), or in no Danger, as other Creatures, from Abroad. If others repolite their Young in Holes (e) and Dens, and secure themselves also therein, it is, because such Guard, such Security is wanting, their Lives being sought either by the Hostility of Man, or to satisfy the Appetite of rapacious Creatures (f). If among Birds, some build their Nests close, some open, some with this, some with another Material, some in Houses, some in Trees, some on the Ground (g), some on Rocks and Crags on high (of which God himself hath given an Instance in the Eagle, Job xxxix. 27, 28.) And so among the Insect and Reptile Kinds, if some reposite their Eggs or Young in the Earth, some in Wood.

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(f) See Note (1).

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tant, in coque manent ufque ad finem Marti, &c. Ol. Mag. Hift.

(b) It

⁽d) Tully having spoken of the Care of some Animals towards their Young, by which they are nursed and brought up, saith, Accedit etiam, ad nonnukorum animantium, earum rerum quas terra gignit, conservationem, & salutem, hominum etiam solertia & diligentia. Nam multa & pecudes, & stirpes sunt, que sine procuratione hominum salva esse non possunt. Cic. de Nat. Deor. 1. 2.

⁽e) Prov. xxx. 26. The Conies are but a feeble Folk, yet make they their Houses in the Rocks.

⁽g) It is a notable Instinct which Ol. Magnus tells of the Galli Sylvestres, in his Northern Country, to secure themselves against the Cold and Storms of the Winter. Cûm nives instarcollium terra supersciem ubsque cooperiunt, ramosque arborum diutius deprimunt & condensant, certos fructus Betula arboris—in sorma longi Piperis vorant, & glutiunt indigestos; idque tanta aviditate, ac quantitate, ut repletum guttur toto corpore majus appareat. Deinde partitis agminibus sese inter medios nivium colles immergunt, prasertim in Jan. Febr. Martio, quando piwes ut turbines, typhones, vel tempestates gravissima è nubibus descendant. Cùmque cooperta sunt,—certis hebdomadis cibo in gutture collecto, egesto, & resumpto vivunt Venatorum canibus non produntur.—Quod si prasentiunt nivem imminere majorem, pradicto fructu, iterum devorato, aliud domicilium cap-

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Wood, some in Stone, some on one Kind of Plant. some on another, some in warm and dry Places, some in the Water, and moist Places, and some in their own Bodies only, as shall be shewn in proper Place; in all these Cases it is in all Probability, the best or only Method the Animal can take for the Hatching and Production of its Young, for their Supplies, Safety, or some other main Point of their Being or Well-being. This is manifest enough in many Cases, and therefore probable in all. manifest that such Animals, for Instance, as breed in the Waters (as not only Fifh, but divers Infects, and other Land-Animals do) that their Young cannot be hatched, fed, or nurfed up in any other Element. It is manifest also, That Insects, which lay their Eggs on this, and that, and the other agreeable Tree, or Plant, or in Flesh, Gc. that it is by that Means their Young are fed and nurfed up. And it is little to be doubted also, but that these Matrixes may much conduce to the Maturation and Production of the Young. And so in all other the like Cases of Nidification, of Heat or Cold, Wet or Dry, Exposed or Open, in all Probability this is the best Method for the Animal's Good, most falutary and agreeable to its Nature, most for its Fecundity, and the Continuance and Increase of its Species; to which every Species of Animals is naturally prompt and inclined.

Thus admirable is the natural Sagacity and Instinct (b) of the irrational Animals in the Conve-

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⁽b) It is a very odd Story (which I rather mention for the Reader's Diversion, than for its Truth) which Dr. Lud. de Beaufort relates. Vir fide dignus narravit mihi, quod cum semel,

CHAP. XIII. Of Animals Habitations. 237 nience and Method of their Habitations. And no less is it in the Fabrick of them. Their architectonick Skill, exerted in the Curiofity and Dexterity of their Works, and exceeding the Skill of Man to imitate; this, I fay, deserves as much or more Admiration and Praise, than that of the most exquifite Artist among Men. For with what inimitable Art (i) do these poor untaught Creatures lay a parcel of rude and ugly Sticks and Straws, Mols and Dirt together, and form them into commodious Nests? With what Curiofity do they line them within, wind and place every Hair, Feather, or Lock of Wool, to guard the tender Bodies of themselves, and their Young, and to keep them warm? And with what Art and Craft do many of them thatch over, and coat their Nests without, to dodge and deceive the Eye of Spectators. as well as to guard and fence against the Injuries of Weather (k)? With what prodigious Subtilty do fome

animi gratia, nidum avicula ligno obturasset; seque occultasset, cupi dus videndi, quid in tali occasione prastaret; illa cum frustra sapius tentasset rostro illud auserre, casus admodum impatiens, abiit, & post aliquod temporis spatium reversa est, rostro gerens plantulam, qua obturamento applicata paulò post, illud veluti telum eripuit tanta vi, ut dispersa impetu berbula, ac eccasionem ipsi, ab avicula ejus virtutem discendi, praripuerit. Cosmog. divina, Sect. 5. Chap. 1. Had he told us what the Plant was, we might have given better Credit to this Story.

⁽i) Of the Subtilty of Birds in Nidification, see Plin. Nat. Hist. 1, 10, c. 33.

⁽k) Among many Inflances that might be given of this Subtilty of Birds, and other Creatures, that of the long-tailed Titmoufe deserves Observation, who with great Art buildsher Nest with Mosses, Hair, and the Webs of Spiders, cast out from them when they take their Flight: See Book VIII. Chap. 4. Note (e), with which the other Materials are strongly tied together. Having neatly built, and covered her Nest

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fome foreign Birds (1), not only plat and weave the fibrous Parts of Vegetables together, and curiously tunnel them, and commodiously Form them into Nests, but also artificially suspend them on the tender Twigs of Trees, to keep them out of the reach of rapacious Animals?

And so for Infects, those little, weak, those tender Creatures; yet, what admirable Artists are they in this Business of Nidification! With what great Diligence doth the little Bee gather its Combs from various Trees (m) and Flowers, the Wast from folid (n) Timber! And with what prodigi-

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with these Materials without; she thatcheth it on the Top with the Muscus arboreus ramosus, or such like broad, whitish Moss, to keep out Rain, and to dodge the Spectator's Eyes and within the lineth it with a great Number of foft Feathers; so many, that I confess I could not but admire how so small a Room could hold them, especially that they could be laid fo close and handsomely together, to afford sufficient Room for a Bird with fo long a Tail, and fo numerous an Iffue as this Bird commonly hath, which Mr. Ray faith, (Synopf. Method. Avium, p. 74.) Ova inter omnes aviculas numerosissima ponit, See more of the Nett of this Bird, from Aldrovand, in Willugh, Ornith. p. 243.

(1) The Nest of the Guira tangeima, the Isterus minor, and the Jupujuba, or whatever other Name the American Hang-Nests may be called by, are of this Kind. Of which see Willughby's Ornith. Lib. 2. Chap. 5. Sett. 12, 13. Alfo Dr. Grew's Museum Reg. Soc. Part 1, Sett. 4. Chap. 4. These Nests I have divers Times feen, particularly ingreat Perfection in our R.S. Repository, and in the noble and well-furnished Museum of my often-commended Friend Sir Hans Sloane; and at the fame Time I could not but admire at the neat Mechanism of them, and the Sagacity of the Bird, in hanging them on the Twigs of Trees, to secure their Eggs and Young from the Apes.

(m) I mention Trees, because I have seen Bees gather the Gum of Fir-Trees, which at the fame Time gave me the Pleafure of feeing their Way of loading their Thighs therewith; performed with great Art and Dexterity.

(n) Wasps, at their first Coming, may be observed to fre-

quent

CHAP. XIII. Of Animals Habitations. 239

ous geometrical Subtilty do those little Animals work their deep hexagonal Cells, the only proper Figure that the best Mathematician could chuse for such a Combination of Houses (0)! With what Accuracy do other Insects perforate the Earth (p), Wood, yea, Stone it self (q)! For which Service, the compleat Apparatus of their Mouths (r), and Feet (s), deserves particular Observation, as hath been

quent Posts, Boards, and other Wood that is dry and sound; but never any that is rotten. These they may be heard to scrape and gnaw; and what they so gnaw off, they heap close together between their Chin and Fore-Legs, until they have gotten enough for a Burden, which they then carry away in

their Mouths, to make their Cells with.

(o) Circular Cells would have been the most capacious; but this would by no Means have been a convenient Figure, by Reason much of the Room would have been taken up by Vacancies between the Circles; therefore, it was necessary to make Use of some of the rectilinear Figures. Among which only three could be of Use; of which Pappus Alexandrin. thus discourseth: Cùm igitur tres sigura sunt, que per seipsas locum circa idem punctum consistentem replere possunt, que per seipsas locum circa idem punctum consistentem replere possunt, Triangulum scil. Quadratum & Hexagonum, Apes illam qua ex pluribus angulis constat sapienter delegerunt, utpote suspicantes eam plus mellis capere quam utram vis reliquarum. At Apes quidem illud tantum quod ipsis utile est cognoscunt, viz. Hexagonum Quadrato & Triangulo esse majus & plus Mellis capere posse nimirum aquali materià in constructionem uniuscujusque consumpta. Nos verò qui plus sapientia quam Apes babere prositemur, aliquid etiam magis insigne investigabimus. Collect. Math. 1.5.

(p) See before Note (c).
(q) See Chap. 11. Note (x).
(r) See Chap. 11. Note (y).

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(s) Among many Examples, the Legs and Feet of the Mole-Cricket, (Gryllotalpa,) are very remarkable. The Fore-Legs are very brawny and strong; and the Feet armed each with four flat strong Claws, together with a small Lamina, with two larger Claws, and a third with two little Claws: Which Lamina is joynted to the Bottom of the Foot, to be extended, to make the Foot wider, or withdrawn within the Foot. These Feet are placed to scratch somewhat Sideways, as well as downward, after the Manner of Moles Feet; and they are very like them also in Figure.

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been, and will be hereafter observ'd. And further yet; With what Care and Neatness do most of those little sagacious Animals line those their Houses within, and seal them up, and sence them without (t)! How artificially will others fold up the Leaves of Trees and Plants (u); others house themselves in Sticks and Straws; others glue light and floating Bodies together (w), and by that Artifice make themselves floating Houses in the Wa-

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Somewhat of this Nature, Swammerdam observes of the Worms of the Ephemeron. To this Purpose, [to dig their Cells,] the Wise Creator hath furnish'd them, (saith he) with fit Members, For, besides that their two Fore-legs are formed somewhat like those of the ordinary Moles, or Gryllotalpa; he hath also surnish'd them with two toothy Cheeks, somewhat like the Sheers of Lobsters, which serve them more readily to bore the Clay. Swammerdam's Ephem. Vit, Publish'd by Dr. Tyson, Chap. 3.

(t) See the before-cited Note (c).

(w) They are for the most Part, some of the Phalena-Tribe, which inhabit the tunnalled, convolved Leaves, that we meet with on Vegetables in the Spring and Summer. And it is a somewhat wonderful Artifice, how so small and weak a Creature, as one of those newly-hatch'd Maggots, (for doubtless it is they, not the Parent-Animal, because she emits no Web, nor hath any tectrine Art,) can be able to convolve the stubborn Leaf, and then bind it in that neat round Form, with the Thread or Web it weaves from its own Body; with which it commonly lines the convolved Leaf, and stops up the two Ends, to prevent its own falling out; and Earwigs, and other noxious Animals getting in.

(w) The several Sorts of Phryganea, or Cadews, in their Nympha, or Maggot-state, thus house themselves; one Sort in Straws, call'd from thence Straw-Worms; others in two or more Sticks, laid parallel to one another, creeping at the Bottom of Brooks; others with a small Bundle of Pieces of Rustes, Duck-weed, Sticks, &c. glu'd together, wherewith they float on the Top, and can row themselves therein about the Waters, with the Help of their Feet: Both these are call'd Cob-bait. Divers other Sorts there are, which the Reader may see a Summary of, from Mr. Willugbby, in Raii Method. Insect. p. 12. together with a good, though very brief Descrip

ters, to transport themselves at Pleasure after their Food, or other necessary Occasions of Life! And for a Close, let us take the scriptural Instance of the Spider, Prov. xxx. 28. which is one of the sour little Things, which, v. 24. Agur says, is exceeding Wise: The Spider taketh hold with her Hands, and is in Kings Palaces (x). I will not dispute the Truth of our English Translation of this Text, but supposing the Animal mention'd to be that which is meant; it is manifest, that the Art of that Species of Creatures, in spinning their various Webs, and the Furniture their Bodies afford to that Purpose, are an excellent Instinct, and Provision of Nature, setting forth its Glorious Author.

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tion of the Papilionaceous Fly, that comes from the Codbait Cadew. It is a notable architectonick Faculty, which all the Variety of these Animals have, to gather such Bodies as are sittest for their Purpose, and then to glue them together; some to be heavier than Water, that the Animal may remain at the Bottom, where its Food is; (for which Purpose they use Stones, together with Sticks, Rushes, &c.) and some to be lighter than Water, to float on the Top, and gather its Food from thence. These little Houses look coarse, and shew no great Artisce outwardly; but are well, tunnelled, and made within with a hard tough Passe; into which the hinder Part of the Maggot is so fix'd, that it can draw its Cell after it any where, without Danger of leaving it behind; as also thrust its Body out, to reach what it wanteth; or withdraw it into its Cell, to guard it against Harms.

(x) Having mention'd the Spider, I shall take this Occasion, (although it be out of the Way) to give an Instance of the Poison of some of them. Scaliger, Exerc. 186. relates, That in Gascony, his Country, there are Spiders of that virulency, that if a Man treads upon them, to crush them, their Poison will pass through

the very Soles of his Shoe. Boyl. Subtil. of Effluv. c. 4.

Mr. Leewenhoek put a Frog and a Spider together into a Glass, and having made the Spider sting the Frog divers Times, the Frog dy'd in about an Hour's Time. Phil. Trans, No. 272.

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And now from this short and transient View of the architectonick Faculty of Animals, especially the Irrationals; we may easily perceive some Superiour and Wise Being was certainly concern'd in their Creation or Original. For, how is it possible that an irrational Creature should, with ordinary and coarse, or indeed any Materials, be ever able to perform such Works, as exceed even the Imi-

In the same Transaction, is a curious Account of the Manner how Spiders lay, and guard their Eggs, viz. they emit them not out of the hindermost Part of the Body, but under the upper Part of her Belly, near the Hind Legs, &c. Also there is an Account of the Parts from which they emit their Webs, and divers other Things worth Observation, with Cuts

illustrating the Whole.

But in Phil. Trans. No. 22. Dr. Nath, Fairfax, from S. Redi, and his own Observations, thinks Spiders not venemous; several Persons, as well as Birds, swallowing them without Hurt: Which I my felf have known in a Person of Learning, who was advis'd to take them medicinally at first, and would at any Time swallow them, affirming them to be fweet, and well tafted: And not only innocuous, but they are very falutiferous too, in some of the most stubborn Difeases, if the pleasant Story in Mouffet be true; of a rich London Matron, cured of a desperate Tympany, by a certain Debauchee, that hearing of her Case, and that she was given over by the Doctors, went to her, pretending to be a Phyfician, and confidently affirming he would Cure her; which The being willing to believe, agrees with him for fo much Money, one half to be paid down, the other upon Cure. Upon which he gives her a Spider, promising her Cure in three Days. Upon which, (not doubting but that he had poison'd her, and fearing he might be call'd to Account for it,) he gets out of Town as fast as he could. But instead of being poison'd, she soon recover'd. After some Months, the Quack gets privately to Town, when he thought the Buftle might be over; and enquiring how his Patient did, was inform'd of her Cure; and thereupon visiting her, and making an Excuse for his Absence, he received his Pay with great Applauso and Thanks. Mouff. Infect. 1. 2. c, 15.

Having faid so much of Spiders, I might here add their Flight: But of this, see Book VIII. Chap. 4. Note (e).

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tation of a rational Creature? How could the Bodies of many of them, (particularly the last mention'd) be furnish'd with architective Materials ? How could they ever discover them to be in their Bodies, or know what Use to make of them? We must therefore necessarily conclude. That the Irrationals either have Reason and Judgment, not only Glimmerings thereof, but some of its Superiour Acts, as Wisdom and Forefight, Discretions Art and Care; or elfe, that they are only passive in the Case, and act by Instinct, or by the Reason of fome Superiour Being imprinted in their Nature, or fome Way or other, [be it how it will,] congenial with them. That they are Rational, or excel Man in Art and Wisdom, none surely will be so foolish as to say: And therefore we must conclude: That those excellent Ends they pursue, and that admirable Art they exert; is none of their own, but owing to that Infinitely Wife and Excellent Being, of whom it may be faid, with Reference to the irrational, as well as rational Creatures, as if is, Prov. ii. 6. The Lord giveth Wisdom; out of his Mouth cometh Knowledge and Understanding.

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CHAP. XIV: Of Animals Self-Preservation:

Aving thus confidered the Food, Cloathing, and Houses of Animals; let us in this Chapter take a Glance of another excellent Provision; the Wife Creator hath made for the Good of the R. 2

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animal World; and that is, the Methods which all Animals naturally take for their Self-Preservation and Safety. And here it is remarkable, (as in the Cases before,) that Man, who is endow'd with Reason, is born without Armature, and is destitute of many Powers, which irrational Creatures have in a much higher Degree than he, by Reason he can make himself Arms to defend himself, can contrive Methods for his own Guard and Sasety, can many Ways annoy his Enemy, and stave off the Harms of noxious Creatures.

But for others, who are destitute of this Supereminent Faculty; they are some Way or other provided with sufficient Guard (a), proportionate to their Place of Abode, the Dangers they are like to incur there (b); and in a Word, to their greatest Occa-

(a) Callent in hoc cunsta animalia, sciuntque non sua modò comme.
d., verùm & h stium adversa; nôrunt sua tela, nôrunt occasiones, partesque dissidentium imhelles. In ventre mollis est tenuisque cutis crecodilo: ideoque se, ut territi, mergent Delphini, subeuntesque alvum illa secant spina. Plin. Nat. Hist. 1. 8. c. 25.

⁽b) Omnibus aptum est Corpus Anma moribus & facultatibus: Equo fortibus ungulis & juba est ornatum (etenim velox & superbum & generosum est animal.) Leoni autem, utpote animoso & ferai, dentibus & unquibus validum. Ita autem & Tauro & Apro; ili enim Cornua, kuic exerti Dentes .- Cervo autem & Lepori (timila enim sunt animalia) velox corpus, sed inerme. Timidis enim velocitas, arma audacibus conveniebant — Homini autem (sapiens enim est-) manus dedit, instrumentum ad omnes artes necessarium, pai non minus quam bello idoneum. Non igitur indiguit Cornu fibi innati cum meliora Cornibus arma manibus, quandocunque volet, possit acipere: Etenim Ensis & Hasta majora sunt Arma, & ad incidendum promptiora ____ Neque Cornu, neque Ungula quicquam nisi comitat agere possunt; Hominum verò arma eminis juxtà ac cominis agunt: telum quidem & Sagitta magis quam cornua. ____ Non igitur est nudus, neque inermis. - fed ips est Thorax ferreus, quandocunque libet, emnibus Coriis difficilius sauciatu organum. - Nec Therax solum set & Domus, & Murus, & Turns, &c. Galen. de Uf. Part. l. I.

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Occasions, and Need of Security. Accordingly, some are sufficiently guarded against all common Dangers, by their natural Cloathing, by their Armature of Shells, or such like hard, and impregnable Covering of their Body (c). Others destitute of this Guard, are armed, some with Horns (d), some with sharp Quills and Prickles (e), some with Claws, some with Stings (f); some can shift and change

(d) Dente timentur Apri: defendunt cornua Tauros: Imbelles Dama quid nisi prada sumus?

Martial: l. 13. Epigr. 94.

(e) The Hedghog being an helpless, slow, and patient Animal, is accordingly guarded with Prickles, and a Power of rolling it self up in them. Clavis terebrari sibi pedes, & discindiviscera patientissime ferebat, omnes cultri itus sine gemitu plusquam Spartana nobilitate concoquens. Borrichius in Blass, de Echino. Panniculum carnosum amplexabatur Musculus pæne circularis, admiranda fabrica, lacinias suas ad pedes, caudam, caput, varie exporrigens, cujus ministerio Echinus se ad arbitrium in orbem contrabit. Act. Dan, in Blasso.

Ifte licet digitos testudine pungat acuta,

Cortice depositio mollis Echinus erit, Mart. 1. 13. Epig. 86. (f) The Sting of a Wasp, or Bee, &c. is so pretty a Piece of Work, that it is worth taking Notice of, so far as I have not found others to have spoken of it. Others have observed

⁽c) Shells deferve a Place in this Survey, upon the Account of their great Variety; the curious and uncouth Make of some, and the beautiful Colours, and pretty Ornaments of others; but it would be Endless to descend to Particulars. Omitting others, I shall therefore only take Notice of the Tortoife-feel, by Reason a great deal of Dexterity appears, even in the Simplicity of that Animal's Skeleton. For, befides that the Shell is a flout Guard to the Body, and affords a fafe Retreat to the Head, Legs and Tail, which it withdraws within the Shell upon any Danger; besides this, I say, the Shell supplieth the Place of all the Bones in the Body except those of the extreme Parts, the Head and Neck, and the four Legs and Tail. So that at first Sight, it is somewhat furprizing to fee a compleat Skeleton confifting of fo finall a Number of Bones, and they abundantly sufficient for the Creature's Use.

change their Colours (g); some can make their Escape by the Help of their Wings, and others by

the Sting to be an hollow Tube, with a Bag of sharp penetrating Juices, (its Poison,) joined to the End of it, within the Body of the Wasp, which is, in Stinging, injected into the Flesh through the Tube. But there are besides this, two small. fharp, bearded Spears, lying within this Tube or Sting, as in a Sheath. In a Wasp's Sting, I counted eight Beards on the Side of each Spear, fomewhat like the Beards of Fish-hooks. Thefe Spears in the Sting, or Sheath, lie one with its Point a little before that of the other; as is represented in Fig. 21, to be ready (I conceive,) to be first darted into the Flesh; which being once fix'd, by Means of its foremost Beard, the other then strikes intoo, and so they alternately pierce deeper and deeper, their Beards taking more and more hold in the Flesh; after which the Sheath or Sting follows, to convey the Poison into the Wound. Which, that it may pierce the better, it is drawn into a Point, with a small Slit a little below that Point, for the two Spears to come out at. By Means of this pretty Mechanism in the Sting, it is, that the Sting when out of the Body, and parted from it, is able to pierce and fling us: And by Means of the Beards being lodged deep in the Flesh, it comes to pass that Bees leave their Stings behind them, when they are disturbed before they have Time to withdraw their Spears into their Scabbard. In Fig. 21, is represented the two Spears as they lie in the Sting. In Fig. 22, the two Spears are represented when squeez'd out of the Sting, or the Scabbard; in which Latter, Fig. Ach, is the Sting, ed, and be, the two bearded Spears thrust out.

(g) The Camelion is sufficiently sam'd on this Account. Besides which, Pliny tells us of a Beast as big as an Ox, called the Tarandus, that when he pleaseth, assumes the Colour of an Ass, and Colorem omnium fruticum, arborum, storum, local rumque reddit, in quibus latet metuens, ideoque raro capitur. Plin.

1. 8. c. 34.

How true this is, there may be some Reason to Doubt; but if any Truth be in the Story, it may be from the Animal's chusing such Company, or Places, as are agreeable to its Colour: As I have seen in divers Caterpillars, and other Insects, who I believe were not able to change their Colour, from one Colour to another; yet I have constantly observed, do fix themselves to such Things as are of the same Colour; by which Means they dodge the Spectator's Eye. Thus the

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the Swiftness of their Feet; some can screen themselves by diving in the Waters, others by tinging and disordering the Waters (b), can make their Escape; and some can guard their Bodies, even in the very Flames, by the Ejection of the Juice of their Bodies (i); and some by their accurate Smell, Sight, or Hearing, can foresee Dangers (k); others by their natural Crast, can prevent or escape them (1); others by their Uncouth Noise (m);

Caterpillar that feeds on Elder, I have more than once feen, fo cunningly adhering to the small Branches of the same Colour, that it might be easily mistaken for a small Stick, even by a careful View. So a large green Caterpillar, that feeds on Buckthorn, and divers others. To which I may add the prodigious Sagacity of the Ichneumon Flies, that make the Kermes, (for of that Tribe all the Kermes I ever saw was;) how artificially they not only inclose their Eggs within that gummy Skin, or Shell; but also so well humour the Colour of the Wood they adhere to, by various Streaks and Colours, that it is not easy to distinguish them from the Wood it self.

(h) Contra metum & vim, suis se armis quaque defendit. Cornibus Tauri, Apri dentibus, mersu Leones, alia suga se, alia occultatione tutantur: atramenti effusione Sepia, torpore Torpedines. Multa etiam insectantes odoris intolerabili sæditate depellunt. Cic. de Nat. Deor. 1. 2. c. 50.

(i) A Knight, call'd Corvini, at Rome, cast a Salamander into the Fire, which presently swell'd, and then vomited Store of thick slimy Matter, which put out the Coals; to which the Salamander presently retir'd, putting them out again in the same Manner, as soon as they-re-kindled, and by this Means sav'd it self from the Force of the Fire for the Space of two Hours: After which it liv'd nine Months. Vid. Philof. Trans. No. 21. in Lowth. Abridg. Vol. 2. p. 816.

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(k) Pliny gives an Instance in each. L. 10. C. 69. Aquila clarius cernunt [quam homines;] Vultures sagacius odorantur: liquidius audiunt Talpa obruta terra, tam denso atque surdo natura elemento.

(1) The Doublings of the Hare, before she goes to Form, thereby to dodge and deceive the Dogs, although a vulgar R 4

(m); by the horrid Aspect, and ugly Gesticulations of their Body (n); and some even by the Power of their Excrements, and their Stink (o), can annov their Enemy, and secure themselves: and against fome (p), the Divine Providence it felf hath provided a Guard.

Observation, is a notable Instinct for an Animal, less fam'd for Cunning than the Fox, and fome others,

(m) It is natural for many Quadrupeds, Birds and Ser-

pents, not only to put on a torvous angry Afpect, when in Danger; but also to fnand, hiss, or by some other Noise de-

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ter their Adversary.

(n) The lynx, or Wryneck, although a Bird of very beautiful Feathers, and confequently far enough off from being any way terrible; yet being in Danger, hath fuch odd Contortions of its Neck, and Motions of its Head, that I remember have fcar'd me, when I was a Boy, from taking their Nefts, or touching the Bird; daring no more to venture my Hand into their Holes, than if a Serpent had lodged in it.

(o) Bonasus tuetur se calcibus & stercore, quod ab se quaternis passibus [trium jugerum longitudine, Plin, Nat. Hift. 1. 8. c. 15.] ejaculatur, quod sepe comburit adeò ut deglabrentur canes. Ray's

Synopf. Quadr. p. 71.

Camelus Peruvianus Clama dictus neminem offendit, sed miro admodum ingenio se ab illata vindicat injuria, nimirum vomitu vel cibi, vel humoris in vexantem retrorsum cum impetu ejaculato, ob protensam

eolli longitudinem. Id. ib. p. 146.

Tzquiepatl (Anglice Squnck Præf. and one that I faw they call'd a Stonck.) Cum quis eam insectatur, fundit cum ventris crepitu balitum fætidissimum : quin ipfa tota teterrimum exhalat odorem. & urina stercusque est fætidissimum, atque aded pestilens, ut nihil sit reperire in nostro orbe, cui in bac re possit comparari : quo fit, ut in periculo constituta urinam & faces ad 8 pluriumve passuum intervalum ejiciat, boc modo se ab omnibus vindicans injuriis, ac vestes inficient maculis luteis indelebilibus. & nunquam satis perspirante odore : alidi innoxium Animal eduleque, kac fola ratione horrendiffinum. Id. ib. P, 182.

Si Accipiter Ardeam in sublimi molestat, stercore immisso in pennai ejus, eas putrescere facit : uti Solinus scribit de Bonaso, &c. Ita & Lupus urinam spargit in persequentem. Ol. Mag. Hift. 1. 19. c. 14.

(p) Thus against the Crocodile, which can catch its Prey only before it, not on one Side. So the Shark, of which take my often-commended Friend Sir Hans Sleane's Observation:

By fuch Shifts and Means as thefe, a sufficient Guard is ministred to every Species of Animals, in its proper respective Place; abundantly enough to fecure the Species from Destruction, and to keep up that Balance, which I have formerly shew'd, is in the World among every, and all the Species of Animals; but yet not enough to secure Individuals, from becoming a Prey to Man, or to other Creatures, as their Necessities of Life require. To which Purpose, the natural Sagacity and Craft of the one intrapping (q), and captivating, being in some Measure equivalent to that of the other in evading, is as excellent a Means for the maintaining the one, as preserving the other; and if well consider'd, argues the Contrivance of the Infinitely Wife Creator and Preserver of the World.

It hath this particular to it, with some others of its own Tribe : that the Mouth is in its under Part, so that it must turn the Belly upwards to Prey. And was it not for that Time it is in turning, in which the pursu'd Fishes escape, there would be nothing that could avoid it; for it is very quick in Swimming, and hath a vast Strength, with the largest Swallow of any Fish, and is very devouring. Sloane's Voyage to Jamaica, p. 23. (9) See Chap. 11. Note (iii).

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CHAP. XV.

Of the Generation of ANIMALS.

Here remains now only one Thing more of the ten Things in common to Animals, and that is what relates to their Generation (a), and Confervation

⁽a) Spontaneous Generation, is a Doctrine to generally exploded, that I shall not undertake the Disproof of it. It is fo evident,

evident, that all Animals, yea, Vegetables too, owe their Production to Parent-Animals and Vegetables; that I have often admir'd at the Sloath and Prejudices of the ancient Philosophers, in so easily taking upon Trust the Aristotelian, or rather, the Egyptian Doctrine of Equivocal Generation; that when they saw Flies, Frogs and Lies, for Instance, to be Male and Female, and accordingly to ingender, lay Eggs, &c. they could ever imagine any of these Creatures should be spontaneously produc'd, especially in so Romantick a Manner, as in the Clouds; as they particularly thought Frogs were, and that they drop'd down in Showers of Rain. For an Answer to this Case of Frogs, I shall refer to a Relation of my own, which my late most ingenious, and learned Friend, the great Mr. Ray, requested of me, and was pleas'd to publish in his last Edition of his Wissom of God manifested, &c. p. 365.

But some will yet affert the Raining of Frogs; among

But some will yet affert the Raining of Frogs; among which the curious Dr. Plot is somewhat of this Opinion; telling us of Frogs sound on the Leads of the Lord Asson's Gate-house, at Tixal in Staffordspire, which he thinks by some such Means came there; as also on the Bowling-Green, frequently after a Shower of Rain. Plot's Hift. Staff. c. 1. sett. 47.

But we may take a Judgment of this, and an Hundred fuch like Reports, to be met with in confiderable Authors, from other the like Reports that have been better enquir'd into. In a Scarcity in Silefia, a mighty Rumour was spread of its raining Millet-Seed; but the Matter being enquir'd into, 'twas found to be only the Seeds of the lvy-leaved Speedwell, or fmall Henbit, growing in the Place in great Plenty. Eph. Germ. An. 3. Obs. 40. So in the Archipelago, it was thought Ashes were rain'd, Ships being cover'd therewith at an hundred Leagues Distance; but in all Probability, it was from an Eruption of Vesuvius, that then happen'd. About Warminster in Wilts, 'twas reported it rain'd Wheat; but a curious Observer, Mr. Cole, found it to be only Ivy-Berries, blown thither in a confiderable Quantity by a Tempest. In the Year 1696, at Cranstead near Wrotham in Kent, a Pasture-Field was overspread with little young Whitings, supposed to fall from the Clouds, in a Tempest of Thunder and Rain; but doubtless they were brought thither with Waters from the Sea by the Tempest. See the before-commended Mr. Lowth. Abridg. Phil. Tranf. Vol. 2. p. 143, 144.

Neither needeth it feem strange, that Aspes, Ivy-Berries, small Fishes, or young Frogs, (which yet may have some other Conveyance,) should be thus transported by tempestuous Winds, considering to what Distance, and in what Quantities, the Sea-Waters were carry'd by the Great Storm, Novemb. 26.

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Sacr. 1

Vol. 2 (b) cium e vation of their Species (b), by that Means. It would not be seemly to advance far in this admirable Work of God; neither shall I at all insist upon that of Man for the same Reason. And as for the Irrationals (c), I shall confine my self to these sive Matters.

I. Their

1703, of which an ingenious Friend sent me these Accounts from Lewes in Sussex, viz. That a Physician travelling soon after the Storm, to Tischurst, twenty Miles from the Sea, as he rode along pluck'd some Tops of Hedges, and chewing them, found them Salt: That some Grapes hanging on the Vines at Lewes were so too. That Mr. Williamson, Restor of Ripe, found the Twigs in his Garden Salt the Monday after the Storm; and others observed the same a Week after. That the Grass of the Downs about Lewes, was so Salt, that the Sheep would not feed till Hunger compell'd them: And that the Miller of Berwick, (three Miles from the Sea,) attempting with his Man to secure his Mill, were so was d with Flashes of Sea-Water, like the Breakings of Waves against the Rocks, that they were almost strangled therewith, and forced to give over their Attempt.

I call'd this Doctrine of Equivocal Generation, an Ægyptian Doctrine; because probably it had its Rise in Ægypt, to salve the Hypothesis of the Production of Men, and other Animals, out of the Earth, by the Help of the Sun's Heat. To prove which, the Ægyptians, (as Diod. Sicul saith,) produce this Observation, That about Thebes, when the Earth is moistned by the Nile, by the Intense Heat of the Sun, an innumerable Number of Mice do spring out. From whence he infers, That all Kinds of Animals, might as well at first come likewise out of the Earth. And from these the learned Bishop Stillingsseet thinks other Writers, as Ovid, Mela, Pliny, &c. have, without examining its Truth, taken up the same Hypothesis. Vid. Stillingsseet's Orig.

Sacr. Part. 2. Book I. Chap. I.

The before-commended Dr. Harris, from the Observations of Dr. Harvey, Sr. Malpighi, Dr. de Graaf, and Mr. Lewenhoeck, infers three Things concerning Generation as highly probable.

1. That Animals are ex Animalculo. 2. That the Animalcules are originally in semine Marium, & non in Foeminis. 3. That they can never come forward, or be formed into Animals of the respective Kind, without the Ova in Foeminis. His Proofs and Illustrations, see under the Word Generation, in his Lex. Techn.

(b) At certe Natura, & fieri potuisset, maxime optasset suum opisicium esse immortale : qued cum per materian; non liceret (nam qued

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I. Their natural Sagacity in chusing the fittest Places to reposite their Eggs and Young.

II. The fittest Times and Seasons they make use

of for their Generation.

III. The due and stated Number of their Young.

IV. Their Diligence and earnest Concern in their Breeding up.

V. Their Faculty of Feeding them, and their

Art and Sagacity exerted therein.

I. The natural Sagacity of irrational Animals, in chusing the fittest Places to reposite their Eggs and Young. Of this I have given larger Hints already than I needed to have done, when I spake of the Architecture (d) of Animals, intending then to have wholly pass'd by this Business of Generation: I shall therefore now only superadd a few other Instances, the more to illustrate this Matter.

It hath been already shown, and will hereafter (e) farther appear, that the Places in which the several Species of Animals lay up their Eggs, and Young, are the best for that Purpose; Waters (f)

(e) Book VIII. Chap. 6.

ex carne est compositum, incorruptibile esse non potest) subsidium quod potuit ipsi ad immortalitatem est fabricata, sapientis cujusdam urbis conditoris exemplo, &c. Nam mirabilem quandam rationem invenit, quomodo in demortui animalis locum, novum aliud sufficiat. Galen. de Usu Part. l. 14. c. 22.

⁽c) Animantia Bruta Obstetricibus non indigent in edendo Partu, eum inditâ Natura vi Umbilicus seipsum occludat. Ol. Rudbeck in Blassi Anat. Felis.

⁽d) Chap. 13.

⁽f) The Ephemeron, as it is an unusual and special Instance of the Brevity of Life; so I take to be a wonderful Instance of the special Care and Providence of God, in the Conservation of the Species of that Animal. For, 1. As an Animal, whose Life is determined in about five or fix Hours Time,

for one; Flesh for another; Holes in Wood (g), Earth, or Stone (b), for others; and Nests for others; and we shall find, that so ardent is the Propensity of all Animals, even of the meanest Insects, to get a sit Place for the Propagation of their Young; that, as will hereafter appear, there is scarce any Thing that escapeth the Inquest of those little subtile Creatures. But besides all this, there are two or three Things more observable, which plainly argue the Instinct of some Superior Rational Being. As,

1. The compleat and neat Order which many Creatures observe in laying up their Seed, or Eggs, in proper Repositories: Of which I shall speak in another Place (i).

2. The suitable Apparatus in every Creature's Body, for the laying-up its Eggs, Seed, or Young,

(viz. from about fix in the Evening, till about Eleven a Clock at Night,) needs no Food; fo neither doth the Ephemeron eat, after it is become a Fly. 2. As to its Generation; in those five Hours of its Life, it performs that, and all other necessary Offices of Life: For in the Beginning of its Life, it sheds its Coat; and that being done, and the poor little Animal thereby render'd light and agile, it spends the rest of its short Time in frisking over the Waters, and at the same time the Female droppeth her Eggs on the Waters, and the Male his Sperm on them to impregnate them. These Eggs are spread about by the Waters; descend to the Bottom by their own Gravity; and are hatch'd by the Warmth of the Sun, into little Worms, which make themselves Cases in the Clay, and feed on the same without any Need of parental Care. Vid. Ephem. wita, translated by Dr. Tyson from Swammerdam. See also Book VIII. Chap. 6. Note (r).

⁽g) See Chap. 13. Note (c), and Book VIII. Chap. 6.

⁽b) The Worms in Chap. 11. Note (2) breed in the Holes they gnaw in Stone, as is manifest from their Eggs found therein.

⁽i) See Book VIII. Chap. 6. Note (q).

BOOK IV.

in their proper Place. It would be as endless as needless to name all Particulars, and therefore an Inflance or two of the Infect-Tribe may ferve for a Specimen in this Place, till I come to other Particulars. Thus Infects, who have neither Feet adapted to scratch, nor Noses to dig, nor can make artificial Nests to lay up their Young; yet what abundant Amends is there made them, in the Power they have either to extend the Abdomen (k), and there-

(k) Many, if not most Flies, especially those of the Fles. Fly-kind, have a Faculty of extending their Uropygia, and thereby are enabled to thrust their Eggs into convenient Holes, and Receptacles for their Young, in Flesh, and whatever elfe they Fly-blow, but none more remarkable than the Horse-Fly, called by Pennius, in Mouffet, (p. 62.) Suchiefe, i. e. Curvicanda, and the Whame or Burrel-Fly, which is vexatious to Horses in Summer, not by stinging them, but only by their bombylious Noise, or tickling them in sticking their Nits, or Eggs on the Hair; which they do in a very dexterous Manner, by thrusting out their Uropygia, bending them up, and by gentle, slight Touches, slicking the Eggs to the Hair of the Legs, Shoulders, and Necks, commonly of Horfes; fo that Horses which go abroad, and are seldom dressed, are somewhat discoloured by the numerous Nits adhering to their Hair.

Having mentioned fo much of the Generation of this Infect, although it be a little out of the Way, I hope I shall be excused for taking Notice of the long-tailed Maggot, which is the Product of these Nits or Eggs, called by Dr. Plot, Eruca Glabra, [or rather Eula Scabra, it should be] caudata aquatico-arborea, it being found by him in the Water of an hollow Tree; but I have found it in Ditches, Saw-Pits, Holes of Water in the High-way, and fuch-like Places where the Waters are most still and foul. This Maggot I mention, as being a fingular and remarkable Work of God, not fo much for its being fo utterly unlike as it is to its Parent Bee-like-Fly, as for the wife Provision made for it by its long Tail; which is so jointed at certain Distances from the Body, as that it can be withdrawn, or sheathed, one Part within another, to what Length the Maggot pleafeth, fo as to enable it to reach the Bottom of very shallow, or deeper Waters, as it

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is muc drical thereby reach the commodious Places they could not otherwise come at; or else they have some aculeous Part or Instrument to terebrate, and make Way for their Eggs into the Root (1), Trunk (m), Fruit

hath Occasion, for the gathering of Food. At the End of this tapering is a Ramissication of Fibrilla, or small Hairs, representing, when spread, a Star; with the Help of which, spread out on the Top of the Waters, it is enabled to hang, making, by that Means, a small Depression or Concavity on the Surface of the Water. In the midst of this Star, I imagine the Maggot takes in Air, there being a Perforation, which with a Microscope I could perceive to be open, and by the Star to be guarded against the Incursion of the Water.

(1) The Excrescences on the Root of Cabbages, Turneps, and divers other Plants, have always a Maggot in them; but what the Animal is that thus makes it's Way to the Root under Ground, whether Ichneumon, Phalana, Scarah, or Scolopendra, I could never discover, being not able to bring them to any

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(m) I presume they are only of the Ichneumon-Fly-kind, that have their Generation in the Trunks of Vegetables. In Malpighi de Gallis, Fig. 61. is a good Cut of the gouty Excrescences, or rather Tumours of the Briar-Stalk: From which proceeds a small black Ichneumon-Fly, with red Legs; black, smooth jointed Amenna; pretty large Thorax; and short, round Belly, of the Shape of an Heart. It leapeth as a Flea. The Male, (as in other Insects,) is lesser than the Female, and very venereous, in spite of Danger, getting upon the Female, whom they beat and tickle with their Breeches and Horns, to excite them to a Coit.

Another Example of the Generation in the Trunks of Vergetables, shall be from the Papers of my often-commended Friend Mr. Ray, which are in my Hands, and that is an Obfervation of the ingenious Dr. Nathaniel Wood: I have (said he) lately observed many Eggs in the common Rush; one Sort are little transparent Eggs, in Shape somewhat like a Pear, or Retort, lying within the Skin, upon, or in the Medulla, just against a brownish Spot on the out-side of the Rush; which is apparently the Creatrix of the Wound made by the Fly, when see puts her Eggs there. Another Kind is much longer, and not so transparent, of a long Oval, or rather cylindrical Form; six, eight, or more, he commonly together, across the

Fruit (n), Leaves (o), and the tender Buds of Vegetables (p), or some other such curious and secure Method they are never destitute of. To which we may add,

3. The natural Poison (q), (or what can I call, it?) which many, or most of the Creatures, last intended, have, to cause the Germination of such

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Rush, parallel to each other, like the Teeth of a Comb, and are as long as the Breadth of the Rush. Letter from Kilkenny in Ireland, April the 28th, 1697.

(n) See Book VIII. Chap. 6. Note (d).

(o) I have in Chap. 13. Note (u), and Book VIII. Chap. 6. Note (e), (f), taken Notice of the Nidification and Generation of fome Insects, on the Leaves of Vegetables, and shall therefore, for the Illustration of this Place, chuse an uncommon Example out of the Scarab-kind (the Generation of which Tribe hath not been as yet mentioned) and that is, of a small Scarab bred in the very Tips of Flm-Leaves. These Leaves, in Summer, may be observed to be, many of them, dry and dead, as also turgid; in which lieth a dirty, whitish, rough Maggot. From which proceeds a Beetle of the smallest Kind, of a light, Weesle Colour, that leapeth like a Grassopper, although its Legs are but short. Its Eyes are blackish, Elysta thin, and prettily surrowed, with many Concavities in them; small club-headed Antenna, and a long Restrum like a Proboscis.

The same, or much like this, I have met with on Tips of Oaken and Holly-Leaves. How the Scarab lays its Eggs in the Leaf, whether by terebrating the Leaf, or whether the Magget, when hatched, doth it, I could never see. But with great Dexterity, it makes its Way between the upper and under Membranes of the Leaf feeding upon the parenchymous Part thereof. Its Head is slenderer and sharper than most of Maggets, as if made on Purpose for this Work; but yet I have often wondered at their Artistice, in so nicely separating the Membranes of the Elm-Leaf, without breaking them, and endangering their own tumbling out of em, considering how thin, and very tender the Skins of that Leaf (par-

ticularly) are.

(p) See Book VIII. Chap. 6. Note (z).
(q) See Book VIII. Chap. 8. to Note (bb), &c.

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Balls, Cases, and other commodious Repositories; as are an admirable Lodgment to the Eggs and Young; that particularly affist in the Incubation and Hatching the Young, and then afford them sufficient Food and Nourishment in all their Nympha-State, in which they need Food; and are afterwards commodious Houses and Beds for them in their Aurelia-State, till they are able to break Prison, fly abroad, and shift for themselves. But this shall be taken Notice of, when I come to treat of Insects.

II. As irrational Animals chuse the fittest Place; fo also the fittest Times and Seasons for their Generation. Some indeed are indifferent to all Times, but others make use of peculiar Seasons (r). Those, for Instance, whose Provisions are ready at all Seafons, or who are under the Tuition of Man, produce their Young without any great Regard to Heat or Cold, Wet or Dry, Summer or Winter. others, whose Provisions are peculiar, and only to be met with at certain Seasons of the Year; or who, by their Migration, and Change of Place, are fied up to certain Seasons; these (as if endowed with a natural Care and Forefight of what shall happen) do accordingly lay, hatch, and nurse up their Young in the most proper Seasons of all the Year for their Purpose; as in Spring, or Summer, the Times of Plenty of Provisions, the Times of Warmth for Incubation, and the most proper Seasons to breed up their Young, till they are able to shift for themselves,

(s) See

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⁽r) Полла ве най прод тад ентрофа той тенин сохавоцена, пойная дон винвиаций ен той апартівной фра. Artist. Hist. An. l. 5. c. 8. ubi plura.

and can range about for Food, and seek Places of Retreat and Safety, by flying long Flights as well as their Progenitors, and passing into far distant Regions, which (when others fail) afford those

helpless Creatures the Necessaries of Life.

III. To the special Seasons, I may add the peculiar Number of Young produced by the irrational Creatures. Of which I have already taken some Notice, when I spake of the Balance of Animals (s). Now, if there was not a great deal more than Chance in this Matter, even a Wife Government of the Creation, it could never happen that every Species of Animals should be tied up to a certain Rate and Proportion of its Increase; the most useful would not be the most fruitful, and the most pernicious produce the fewest Young, as I have obferved it commonly is. Neither would every Species produce such a certain Rote as it is only able to breed up: But all would be in a confused, huddled State. Instead of which, on the contrary, we find every Thing in compleat Order; the Balance of Genera, Species and Individuals always proportionate and even; the Balance of Sexes the same; most Creatures tied up to their due Stint and Number of Young, without their own Power and Choice, and others (particulary of the winged (t)Kind)

(s) See Chap. 10.

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⁽t) Mr. Ray alledges good Reasons to conclude, That although Birds have not an exact Power of numbering, yet, that they have of distinguishing many from few, and knowing when they come near to a certain Number; and that they have it in their Power to lay many or few Eggs. All which he manifesteth from Hens, and other domestick Fowls, laying many more Eggs when they are withdrawn, than

Kind) producing their due Number at Choice and Pleasure; some large Numbers, but not more than they can cover, feed and foster; others fewer, but as many as they can well nurse and breed up. Which minds me,

IV. Of the Diligence and earnest Concern which irrational Animals have of the Production and Breeding up their Young. And here I have already taken Notice of their 27093, or natural Affection, and with what Zeal they feed and defend their Young. To which may be added these two

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utterly impossible, that ever unthinking, untaught Animals should take to that only Method of hatching their Young, was it not implanted in their Nature by the Infinitely Wise Creator. But so ardent is their Desire, so unwearied is their Patience when they are ingaged in that Business, that they will abide their Nests for several Weeks, deny themselves the Pleasures, and even the Necessaries of Life; some of them even starving themselves almost, rather than Hazard their Eggs, to get Food; and others either performing the Office by Turns (u), or else the one kindly seeking out, and carrying Food to the other (w), engaged in the

when not. Which holds in wild as well as domestick Birds, as appears from Dr. Lister's Experiment in withdrawing a Swallow's Eggs, which by that Means laid nineteen Eggs successively before she gave over. Vide Ray's Wisdom of God, &c. p. 137.

⁽u) Palumbes incubat fæmina post meridiana in matutinum, cetero mas. Columba incubant ambo, interdiu Mas, nostu Fæmina. Plin. Nat. Hist. 1. 10. c. 58.

⁽w) Of the common Crow, Mr. Willinghby faith, The Fe-

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Office of Incubation. But of these Matters in a

more proper Place (x).

with what Care do they feed and nurse them; but with what surprizing Courage do all or most Creatures defend them! It is somewhat strange to see timid Creatures (y), who at other Times are cowardly, to be full of Courage, and undaunted at that Time; to see them suriously and boldly encounter their Enemy, instead of slying from him; and expose themselves to every Danger, rather than hazard and forsake their Young.

With this earnest Concern of the irrational Ani-

mals for their Young, we may join in the

V. And last Place, Their Faculty and Sagacity of feeding them. About which I shall take Notice

of three Things.

1. The Faculty of Suckling the Young, is an excellent Provision the Creator hath made for those helpless Creatures. And here the Agreeableness and Suitableness of that Food to young Creatures, deferves particular Observation; as also their Delight in it, and Desire and Endeavours after it, even as

males only sit, and that diligently, the Males in the mean Time bring them Victuals; as Aristotle saith. In most other Birds, which pair together, the Male and Female sit by Turns. Ornithol. lib. 2. sect. 1. cap. 2. sect. 2. And I have observed the Female-Crows to be much fatter than the Males, in the Time of Incubation; by Reason the Male, out of his conjugal Affection, almost starves himself, to supply the Female with Plenty.

⁽x) See Book VII. Chap. 4.

(y) Volucribus Natura novam quandam, Pullos educandi, rationem excogitavit: ipsis enim pracipuum quendam amorem in ea qua procrearent, ingeneravit, quo impulsu bellum pro pullis cum ferocibus animalibus, qua ante declinârunt, intrepidê suscipiunt, victúmque ipsis convenientem suppeditant. Galen de Us. Part. 1. 14. c. 4.

(2) In

foon as born (z), together with the Willingness of all, even the most savage and fierce Animals, to part with it, and to administer it to their Young, yea, to teach and institute them in the Art of

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And lastly, to name no more, the curious Apparatus which is made for this Service in the divers Species of Animals, by a due Number of Breafts, proportionable to the Occasions of each Animal, by curious Glands in those Breasts, to separate that nutritive Juice, the Milk, by Arteries and Veins to convey it to them, and proper Rivulets and Chanels to convey it from them, with Dugs and Nipples, placed in the most convenient Part of the Body (aa) of each Animal, to administer it to their Young; all these Things, I say, do manifestly proclaim the Care and Wisdom of the Great Creator. 2. As

(z) In iis animantibus que lacte aluntur, omnis ferè cibus matrum lastescere incipit: eaque, qua paulo ante nata sunt, sine magistro, duce natura, mammas appetunt, earumque ubertate saturantur. Atque ut intelligamus nibil borum effe fortuitum, & bac omnia effe provida, sclertisque natura, qua multiplices fætus procreant, ut Sues, ut Canes, bis Mammarum data est multitudo; quas easdem paucas habent ea bestia. que pauca gignunt. Cic. de Nat. Deor. 1. 2. c. 51, Consule quoque

Galen de Uf. Part. 1. 14. c. 4. & l. 15. c. 7.

⁽aa) Animalia solidipeda. & ruminantia, vel cornigera, interfemora Mammas habent, quorum Fætus statim à partu pedibus insistunt, quod matres inter lastandum non decumbant, ut Equa, Asina, &c. Animalia digitata & multipara in medio ventre, scil. spatio ab inguine ad pectus (in Cuniculo usque ad jugulum) duplicem mammarum seriem sortita Sunt, que omnia decumbentia ubera foetibus admovent, ut Ursa, Leana, &c. Si verò hac in solo inguine Mammas gererent, propria cura inter decumbendum fœt ûs accessum ad mammas nonnibil prapedirent. Mulieribus Mamma bina sunt, ut & Papika, nimirum ut latus lateri conformiter respondeat. Out alternation infans à latere in latus inter sugendum transferatur, ne corpus ejus uni lateri nimis assuescens quoquo modo incurvetur. Simia, homo Sylvestris, &c. Blaf. Anat. Animal. Part. 1. Cap. 6. de Cane ex Whartono. See here what Pliny hath alfo, Lib. 11. Cap. 40.

2. As for such Animals as do in another Manner breed up their Young, by finding out Food, and putting it into their Mouth, the Provision made in them for this Service, to strike, catch, to pouch and convey their Prey and Food to their Young (bb), is very considerable. And so is also their Sagacity in equally distributing it among them, that among many, all shall be duly, equally, and in good Order, sed.

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In the Elephant, the Nipples are near the Breast, by Reason the old One is forced to suck her self, and by the Help of her Trunk conveys the Milk into the Mouth of her Young. Vide

Phil. Trans. No. 336.

(bb) For an Exemplification, I might name many Animals, particularly Birds, whose Parts are compleatly fuited to this Service. They are Characteristicks of rapacious Birds, to have aduncous Bills and Talons to hold and tear; and ftrong brawny Thighs to strike and carry their Prey; as well as a Tharp piercing Sight to fpy it afar off. Rait Synops. Method. Av. p. 1. The Pelecane also might be here named, for its prodigious Bag under its Bill and Throat, big enough to contain thirty Pints. Id. ibid. p. 122. And to name no more, the common Heron hath its most remarkable Parts adapted to this Service; long Legs for wading; and a long Neck answerable thereto to reach Prey; a wide, extensive Throat to pouch it; long Toes, with strong hooked Talons, (one of which is remarkably ferrate on the Edge) the better to hold their Prey; a long sharp Bill to strike their Prey, and serrate towards the Point, with sharp hooked Beards standing backward, to hold their Prey fast when struck; and lastly, large, broad, concave Wings (in Appearance much too large, heavy, and cumbersome for so small a Body, but) of greatest Use to enable them to carry the greater Load to their Nests, at several Miles Distance; as I have seen them do from several Miles beyond me, to a large Heronry above three Miles distant from me. In which I have feen Plaife, and other Fifh, fome Inches long, lying under the high Trees in which they build; and the curious and ingenious Owner thereof, D' Acre Barret, Efq; hath feen a large Eel convey'd by them, notwithstanding the great Annoyance it gave them in their Flight, by its twifting this Way and that Way about their Bodies, (cc) This 3. There is yet another Instinct remaining, of such Animals as can neither administer Suck to their Young, neither lay them in Places affording Food, nor can convey and bring them Food, but do with their Eggs, lay up Provisions for their future Young. Somewhat of this is reported of some Birds (cc); but I have my self, with Pleasure, frequently seen some of the Species of Insects to carry ample Provisions into their dry and barren Cells, where they have sealed them carefully and cautiously up with their Eggs, partly, it is like, for Incubation-Sake, and partly as an easy Bed to lodge their Young; but chiefly, for suture Provision for their Young, in their Nympha-State, when they stand in Need of Food (dd).

(ce) This is reported of the American Offrich, mentioned by Acarette, in Philosoph. Trans. No. 89. Of which see Book VII. Chap. 4. Note (e).

(dd) Hornets, Wasps, and all the Kinds of Bees provide Honey; and many of the Pseudosphece, and Ichneumon Wasps and Flies, carry Maggots, Spiders, Sc. into their Nests; of which see above, Chap. 13. Note (c).

CHAP. XVI. The Conclusion.

THUS I have, as briefly as well I could (and much more briefly than the Matters deserved) dispatched the Decad of Things I proposed in common to the sensitive Creatures. And now let us pause a little, and reflect. And upon the whole Matter, what less can be concluded than that there is a Being Infinitely Wise, Potent, and Kind, who is able to contrive and make this Glorious Scene of Things, which I have thus given only a Glance of Things.

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Book IV.

Globe with fuch a noble Set of Animals? All fo contrived, as to minister to one another's Help some Way or other, and most of them serviceable to Man peculiarly, the Top of this lower World, and who was made, as it were, on Purpose to observe. and furvey, and fet forth the Glory of the Infinite Creator, manifested in His Works! Who! What, but the Great God could so admirably provide for the whole Animal World every Thing ferviceable to it, or that can be wished for, either to conserve its Species, or to minister to the Being or Wellbeing of Individuals! Particularly, who could Feed fo spacious a World, who could please lo large a Number of Palates, or fuit fo many Palates to fo great a Variety of Food, but the Infinite Confervator of the World! And who but the same Great HE, could provide fuch commodious Cloathing for every Animal; fuch proper Houses, Nests, and Habitations; fuch suitable Armature and Weapons; fuch Subtilty, Artifice, and Sagacity, as every Creature is more or less armed and furnished with, to fence off the Injuries of the Weather, to rescue it self from Dangers, to preserve it self from the Annoyances of its Enemies; and, in a Word, to conserve its Self, and its Species! What but an Infinite Superintending Power could so equally Ralance the several Species of Animals, and conferve the Numbers of the Individuals of every Species so even, as not to Oyer or Under-people the Terraqueous Globe! Who, but the Infinite Wile LORD of the World, could allot every Creature its most suitable Place to live in, the most suitable Element to Breath, and Move, and Act in. who CHAP. XVI. The Conclusion.

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who but HE could make so admirable a Set of Organs, as those of Respiration are, both in Land and Water-Animals! Who could contrive fo curious a Set of Limbs, Joints, Bones, Muscles, and Nerves, to give to every Animal the most commodious Motion to its State and Occasions! And to name no more, What Anatomist, Mathematician, Workman, yea, Angel, could contrive and make fo curious, fo commodious, and every Way fo exquifite a Set of Senses, as the Five Senses of Animals are; whose Organs are so dexterously contrived. so conveniently placed in the Body, so neatly adjusted, so firmly guarded, and so compleatly suited to every Occasion, that they plainly set forth the Agency of the Infinite Creator and Conservator of the World.

So that here, upon a transient View of the Animal World in General only, we have such a Throng of Glories, such an enravishing Scene of Things as may excite us to Admire, Praise, and Adore the Infinitely Wise, Powerful, and Kind CREATOR; to condemn all Atheistical Principles; and with Holy David, Psalm xiv. 1. to conclude, That he is in good Earnest a Fool, that dares to say, There is no GOD, when we are every where surrounded with such manifest Characters, and plain Demonstrations of that Infinite Being.

But in the next BOOK we shall still find greater Tokens, if possible, when I come to take a View

of Animals in Particular.

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SURVEY

Of the Particular

Tribes of ANIMALS.

of the Things in common to Animals, my Bufiness in the next, will be to inspect the particular Tribes, in order to give further Manifestations of the Infinite Creator's Wisdom, Power and Goodness towards the Animal World.

KANKAMKANKAN-KANBKANKAMKANKANKA

BOOK V.

A SURVEY of MAN.

Notice of, shall be Man, who may justly claim the Precedence in our Discourse, inasmuch as GOD hath given him the Superiority in the Animal World; Gen. i. 26. And God said,

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said, Let us make Man in our Image, after our Likeness; and let them have Dominion over the Fish of the Sea, and over the Fowl of the Air, and over the Cattle, and over all the Earth, and over every creeping Thing that creepeth upon the Earth.

And as to Man, we have so excellent a Piece of Workmanship, such a Microscosm, such an Abridgment of the Creator's Art in him, as is alone sufficient to demonstrate the Being and Attributes of GOD. Which will appear, by considering the Soul and the Body of Man.

CHAP. I.

Of the Soul of MAN.

MY Survey of Man, I shall begin with the Soul of Man, by Reason it is his most Noble Part (a), the Copy of the Divine Image in us (b), in which we have enough to fill us with Admiration of the Munisicence, Power, and Wisdom of the Infinite

Claud, de 4 Conful. Hon.

⁽a) Jam verò Animum ipsum, Mentemque hominis, Rationem, Conilium, Prudentiam, qui non divinà curà persetta esse perspicit, is his ipis rebus mihi videtur carere. Cic. de Nat. Deor. 1. 2. c. 59.

⁽b) Sensum à Cœlesti demissum traximas arce,
Cujus egent prona, & terram spectantia: mundi
Principio indulsit communis Conditor, illis
Tantum Animas; nobis Animum quoque.

Juven. Sat. xv. V. 144.

Et cum non aliter possent mortalia fingi. Adjunxit geminas, illa cum corpore lapsa Intereunt: hac sola manet, bustoque superstes Evolat.

Infinite Creator (c), when we contemplate the Noble Faculties of this our Superiour Part, the vast Reach and Compass of its *Understanding*, the prodigious Quickness and Piercingness of its *Thought*, the admirable Subtilty of its *Invention*, the commanding Power of its *Wisdom*, the great Depth of its *Memory* (a), and in a Word, its *Divine Nature* and *Operations*.

But I shall not dwell on this, tho' the Superiour Part of Man, because it is the least known. Only

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(c) Nam siquis nulli secta addictus, sed libera sententia rerum considerationem inierit, conspicatus in tanta carnium ac succorum colluvit tantam mentem babitare; conspicatus item & cujusvis animalis constructionem (omnia enim declarant Opisicis Sapientiam) Mentis, qua bomini inest, excellentiam intelliget, tum opus de partium utilitate, qua prius exiguum esse sibi videbatur, persetissima Theologia verum principium constituet: qua Theologia multi est major atque prastantior totà Medicina. Galen de usu Part. l. 17. c. 1.

(d) Among many Examples that I could give of Persons famous for Memory, Seneca's Account of himfelf may be one. Hanc [Memoriam] aliquando in me floruisse, ut non tantum ad usum Sufficeret, sed in miraculum usque procederet, non nego. Nam & 2000 nominum recitata, quo ordine erant dista, reddeham : & ab his qui ad audiendum praceptorem nostrum convenerunt, singulos versus à singulus datos, cum plures quam 200 efficerentur, ab ultimo incipiens usque al primum recitabam. After which, mention is made of the great Memory of Latro Porcius (chariffimi mihi sodalis, Seneca callshim) who retained in his Memory all the Declamations he had ever spoken, and never had his Memory fail him, not to much as in one fingle Word. Also, he takes Notice of Cyneas, Ambassador to the Romans, from King Pyrrbus, who in one Day 'had fo well learn'd the Names of his Spectators, that postero die novus homo & Senatum, & omnem urbanam circumfusas Senatui plehem, nominibus suis persalutavit. Senec. controvers. 1, init. Vid. quoque Plin. 1. 7. c. 24. where he also adds 0ther Examples, viz. Cyrus rex omnibus in exercitu suo militibus m mina reddidit; L. Scipio populo Rom. Mithridates 22 gentium res, totidem linguis jura dedit, pro concione singulas sine interprete affatu. Charmidas (seu potius Carneades) - que quis exegerat volumina! bibliothecis, legentis modo representavit.

(e) Diver-

CHAP. I. Of Man's Inclinations.

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there are two Things I cannot easily pass by, because they manifest the especial Concurrence and Design of the Infinitely Wise Creator, as having a particular and necessary Tendency to the Management and good Order of the World's Affair. The

of Men's Minds to this, and that, and the other Business (e). We see how naturally Men betake themselves to this and that Employment: Some delight most in Learning and Books, some in Divinity, some in Physick, Anatomy and Botany, some in Critical Learning and Philology, some in Mathematicks, some in Metaphysicks, and deep Researches; and some have their Delight chiefly in Mechanicks, Architecture, War, Navigation, Commerce, Agriculture; and some have their Inclinations lie even to the service Offices of the World, and an hundred Things besides.

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Now all this is an admirably wife, as well as most necessary Provision, for the easy and sure transacting the World's Affairs; to answer every End and Occasion of Man, yea, to make Man helpful to the poor helpless Beasts, as far as his Help is needful to them; and all, without any great Trouble, Fatigue, or great Inconvenience to Man; rather as a

Plea-

⁽e) Diversis etenim gaudet natura ministris, Ut sieri diversa queant ornantia terras. Nec patitur cunstos ad eandem currere metam, Sed varias jubet ire vias, variosque labores Suscipere, ut vario cultu sit pulchrior orbis.

Paling, in Scorp.

Outos & martesse Oeds Xaplevta Sidose

[&]quot;Av Seacre, &c. Ita non omnibus hominibus sua dona dat Deus, que bonam indolem, neque prudentiam, nec eloquentiam: alius name

270 Of Man's Invention. BOOK V.

Pleasure and Diversion to him. For so far it is from being a Toil, that the greatest Labours (f), Cares, yea, and Dangers too, become pleasant to him who is pursuing his Genius; and whose Ardour of Inclination eggs him forward, and buoys him up under all Opposition, and carrieth him through every Obstacle, to the End of his Designs and Desires.

II. The next is, The inventive Power of the Soul (g). Under which I might speak of many Things; but I shall take Notice only of Two, because they manifest the particular Concern and Agency of the Infinitely Wise Creator. The

1. Is, That Man's Invention should reach to such a great Variety of Matters; that it should hit upon every Thing that may be of any Use, either to himself, or to Human Society; or, that may any Ways promote (what in him lies,) the Benefit of this lower Part of the Creation.

For the Illustration of this, I might take a View of all the Arts and Sciences, the Trades, yea, the very Tools they perform their Labours, and Con-

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wiltum habet deformem; sed Deus formam eloquentia ornat, &e, Homer Odys. 8. The like also in Iliad. 1.13.

⁽f) Although Solomon declares, Eccles. xii. 12. That much Study is a Weariness to the Fless; yet we see with what Pleasure and Assiduity many apply themselves to it. Thus Cicero tells of Cato, whom he casually found in Luculius's Library, M. Catonem vidi in Bibliotheca sedentem, multis circumsusum Stoicorum libris. Erat enim, ut scis, in eo inexhausta aviditas legendi, nec satiari poterat: quippe ne reprehensionem quidem vulgi inanem resormidans, is ipsa curia soleret legere sape, dum senatus cogeretur—ut Heluo librorum—videhatur. Cicer. de sinib. 1. 3. c. 2.

⁽g) Mentem hominis, quamvis cam non videas, ut Deum non vides, tamen ut Deum agnoscis ex operibus ejus, sie ex memoria rerum, & Inventione, & celeritate motus, omnique pulchritudine virtutis vim divinam mentis agnosoito. Cicer. Tusc. Quæst. 1. 1. c. 29.

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trivances with, as numerous as their Occasions and Contrivances are various. Indeed, What is there that falleth under the Reach of Man's Senses, that he doth not employ to some Use and Purpose, for the World's Good? The celestial Bodies, the Sun. the Moon, with the other Planets, and the fix'd Stars, he employs to the noble Uses of Astronomy, Navigation and Geography. And, What a noble Acumen, what a vast Reach must the Soul be endow'd with, to invent those curious Sciences of Geometry and Arithmetick, both Specious, and in Numbers; and those nice and various Instruments, made use of by the Geometrician, Astronomer, Geographer and Sailor ? And laftly, What a wonderful Sagacity is shewn in the Business of Opticks, and particularly in the late Invention of the Telescope: wherewith new Wonders are discover'd among God's Works, in the Heavens, as there are here on Earth, with the Microscope, and other Glasses.

And as for this lower World, What Material is here to be found; what kind of Earth, or Stone, or Metal; what Animal, Tree, or Plant, yea, even the very Shrubs of the Field; in a Word, what of all the excellent Variety, the Creator has furnish'd the World with, for all its Uses and Occasions, in all Ages; what, I say, that Man's Contrivance doth not extend unto, and make some Way or other advantagious to himself, and useful for Building, Cloathing, Food, Physick, or for Tools or Utensils, or for even only Pleasure and Diversion?

But now considering the great Power and Extent of Human Invention.

2. There is another Thing, that doth farther demonstrate the Super-intendence of the Great Crea-

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tor, and Conservator of the World; and that is, That Things of great, and absolutely necessary Use, have foon, and eafily occurr'd to the Invention of Man; but Things of little Use, or very dangerous Use, are rarely and flowly discover'd, or still utterly undiscover'd. We have as early as the Mosaick History, an Account of the Inventions of the more useful Crafts and Occupations: Thus Gen. iii. 23. Adam was fent forth from the Garden of Eden, by God himself, to till the Ground. And in the next Chapter, his two Sons Cain and Abel; the one was of the same Occupation, a Tiller of the Ground, the other a Keeper of Sheep (b). And the Posterity of these, are in the latter End of Gen. iv. recorded, Jabal, to have been the Father of such as dwell in Tents (i); i.e. He was the Inventor of Tents, and pitching those moveable Houses in the Fields, for looking after, and depasturing their Cattel in the Defarts, and uncultivated World. Tubal-Cain was an Instructor of every Artificer in Brass and Iron (k), or the First that found out the Art of melting, and malleating (1) Metals, and making them useful for Tools, and other neceffary Implements. And his Sifter Naamah whose Name is only mention'd, is by some thought to have been the Inventor of Spinning and Cloath ing. Yea, the very Art of Musick is thus early afcibed to Fubal (m); so indulgent was the Creaton

⁽h) Gen. iv. 2.

⁽i) Verf. 20.

⁽k) Verf. 22.

⁽¹⁾ Σουφκόπ G, the LXX call him, i, e. A Worker with an Hammer.

⁽m) Verf. 21.

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to find a Means to divert Melancholy, to cheer the Spirits, and to entertain and please Mankind. But for Things of no Use, or but little Use, or of pernicious Consequence; either they have been much later thought of, and with great Dissiculty, and perhaps Danger too, brought to pass; or else they still are, and perhaps will always remain, Exercises of the Wit and Invention of Men.

Of this we might give divers Inflances: In Mathematicks, about squaring the Circle (n); in Mechanicks

⁽n) Although the Quadrature of the Circle, hath in former Ages exercis'd some of the greatest mathematical Wits; yet nothing has been done in that Way fo confiderable, as in, and fince the Middle of the last Century; when in the Year 1657, those very ingenious and great Men, Mr. William Neile, and my Lord Brounker, and Sir Christopher Wren afterwards, in the same Year, geometrically demonstrated the Equality of fome Curves to a strait Line. Soon after which, others at Home, and Abroad, did the like in other Curves. And not long afterwards, this was brought under an analytical Calculus: The first Specimen whereof, that was ever publish'd, Mr. Mercator gave in 1688, in a Demonstration of my Lord Brounker's Quadrature of the Hyperbola, by Dr. Wallis's Reduction of a Fraction, into an infinite Series by Division. But the penetrating Genius of Sir Isaac Newton, had discover'd a Way of attaining the Quantity of all quadrible Curves analytically, by his Method of Fluxions, some Time before the Year 1668, as I find very probable from an Historical Account, in a long Letter of Mr. Collins, written in his own Hand, and fent to Richard Townley, Esq; of Lancasbire, whose Papers are in my Hands. In that Letter, Mr. Collins faith, That in September 1668, Mr. Mercator publifo'd his Logarithmotechnia, one of which he foon fent to Dr. Barrow, who thereupon fent him up some Papers of Mr. Newton's, I now Sir Isaac : 7 by which, and former Communications made thereof by the Author, to the Doctor; it appears that the faid Method was invented some Years before, by the said Mr. Newton, and generally apply'd. And then he goes on to give some Account of the Method; what it performs in the Circle, &c. what Mr. Gregory had done in that kind, who intended to publift somewhat in Latin about it, but would

chanicks (0), about the Art of Flying; and in Navigation, about finding the Longitude. Things, although some of them in Appearance innocent, yea, perhaps very useful, yet remain for the most Part secret; not because the Discovery of most of them is more impossible, or difficult than of many other Things, which have met with a Difcovery; nor is it for want of Man's Diligence therein, or his careful Pursuit and Enquiry after them, (for perhaps, nothing already discover'd hath been more eagerly fought after;) but with much better Reason, (I am sure with greater Humility and Modefty,) we may conclude it is, because the Infinitely Wife Creator, and Ruler of the World, hath been pleas'd to lock up these Things from Man's Understanding and Invention, for some Reasons best known to Himself, or because they might be of ill Consequence, and dangerous amongst Men.

As in all Probability the Art of Flying would particularly be: An Art which in some Cases might be of good Use, as to the Geographer and Philosopher; but in other Respects, might prove of dangerous and satal Consequence: As for Instance, By putting it in Man's Power to discover the Secrets of Nations and Families, more than is consistent

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more of this Nature. The Design, I find, of that indefatigable Promoter of Mathematicks, Mr. Collins, was to acquaint Mr. Townley, in his Letter, with what had been done; and to get the Assistance of that ingenious Gentleman, towards the compleating a Body of Algebra.

⁽⁰⁾ I do not mention here the perpetual Motion, which hath exercis'd the mechanical Wits for many Ages; because it is a Thing impossible, if not a Contradiction: As the beforecommended Dr. Clarke afferts in Rehaul. Phys., p. 133.

with the Peace of the World, for Man to know; by giving ill Men greater Opportunities to do Mischief, which it would not lie in the Power of others to prevent; and, as one (p) observes, by making Men less sociable: "For upon every true or false Ground of Fear, or Discontent, and other Occasions, he would have been fluttering away to some other Place; and Mankind, instead of cohabiting in Cities, would, like the Eagle, have

" built their Nests upon Rocks".

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That this is the true Reason of these Matters, is manifest enough from Holy Scripture, and Reason (q) also gives its Suffrage thereto. The Scriptures expresly tell us, That every good Gift, and every perfeet Gift, is from above, and cometh down from the Father of Lights, St. James i. 17. Solomon, Prov. ii. 6. faith, The Lord giveth Wisdom; out of his Mouth cometh Knowledge and Understanding: And Elibu is very express, 70b xxxii. 8. But there is a Spirit in Man, and the Inspiration of the Almighty giveth them Understanding, Thon Tays Tonparopos is in it Sidanusa, as the LXX render it, The Inspiratus, the Afflatus of the Almighty, is their Instructor, Mistress or Teacher. And in Scripture, not only the more noble, superiour Acts of Wisdom or Science; but much inferiour also, bear the Name of Wisdom, Knowledge and Understanding, and are ascrib'd unto GOD. 'Tis well known that Solomon's Wifdom is wholly afcrib'd unto GOD; and the Wisdom and Understanding which GOD is faid to have given him, I Kings iv:

⁽p) Grew's Cofmol. Sacril. 1. c. 5. fest. 25.

⁽⁹⁾ Nemo igitur vir magnus sine aliquo afflatu divino unquam fult; Cics de Nat. Deor. l. 2. c. 66. T 2 (r) Ægypt;

Of Man's Invention. BOOK V. iv. 29. is particularly fet forth in the following Verses, by his great Skill in moral and natural Philofophy, in Poctry, and probably in Aftronomy, Geometry, and fuch other of the politer Sciences, for which Agypt, and the Eastern Nations were celebrated of Old (r): And Solomon's Wisdom excelled the Wisdom of all the Children of the East Country, and all the Wisdom of Agypt. For he was wifer than all Men, than Ethan, Gc. And he spake 3000 Proverbs: And his Songs were 1005. And he spake of Trees, from the Cedar to the Hystop of the Wall, (i.e. of all Sorts of Plants; also of Beasts, Fowl, creeping Things, and Fishes. So likewise the Wisdom of Daniel. and his three Companions, is afcrib'd unto GOD, Dan. i. 17. As for these four Children, Godgace them Knowledge, and Skill in all Learning and Wisdom; and Daniel had Understanding in all Visions and Dreams. And accordingly in the next Chapter, Daniel acknowledgeth and praifeth God, ver. 20, 21. Daniel answered and said, Bleffed be the Name of God for ever and ever, for Wisdom and Might are his .---- He giveth Wisdom unto the Wise, and Knowledge to them that know Understanding. But not only Skill in the Superiour Arts and Sciences; but even in the more inferiour mechanick Art, is call'dby the fame Names,

⁽r) Ægypt, and some of the Eastern Nations, are celebrated for their Skill in polite Literature; both in Scripture and prosane Story: Job was of those Parts; so were the Zood and Moyer, the Brachmans and Gymnosophists. Moses and Daniel had their Education in these Parts: And Pythagoras, Democritus, and others, travell'd into these Parts for the Sake of their Learning.

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Names, and ascrib'd unto GOD: Thus for the Workmanship of the Tabernacle, Exod. xxxi. 2. to ver. 6. See, I have called Bezaleel; and I have filled him with the Spirit of God, in Wisdom, and in Understanding, and in all Manner of Workmanship: To devise cunning Works, to work in Gold, Silver and Brass; and in cutting of Stones, to set them; and in carving of Timber, to work in all Manner of Workmanship. So the Spinsters, Weavers, and other Crafts-people, are call'd wife-hearted, Exod. xxxiv. 10, 25, and other Places. And in Exod. xxxvi. 1, &c. the LORD is faid to have put this Wisdom in them, and Understanding to know how to work all these Manner of Works, for the Service of the Sanctuary. And lastly, to name no more Instances, Hiram the chief Architect of Solomon's Temple, is in 1 Kings vii. 14. and 2 Chron. ii. 14. call'd a cunning Man, filled with Wisdom and Understanding, to work in Gold, Silver, Brass, Iron, Stone, Timber, Purple, Blue, fine Linnen, and Crimfon; also to grave; and find out every Device which should be put to him.

Thus doth the Word of God, ascribe the Contrivances and Crasts of Men, to the Agency, or Insuence of the Spirit of God, and upon that of Man. And there is the same Reason for the Variety of Genii, or Inclinations of Men also; which from the same Scriptures may be concluded to be a Designation, and Transaction of the same Almighty Governour of the World's Affairs. And who indeed but HE, could make such a Divine Substance, endow'd with those admirable Faculties, and Powers, as the rational Soul hath; a Being to bear the

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Great Creator's Vicegerency in this lower World; to employ the feveral Creatures; to make Use of the various Materials; to manage the grand Businesses; and to survey the Glories of all the visible Works of God? A Creature, without which this lower World would have been a dull, uncouth, and desolate kind of Globe. Who, I say, or what less than the Infinite GOD, could make such a rational Creature, fuch a Divine Substance as the Soul! For if we should allow the Atheist any of his nonfenfical Schemes, the Epicurean his fortuitous Concourse of Atoms, or the Cartesian (s) his created Matter put in Motion; yet with what tolerable Sense could he, in his Way, produce such a Divine, thinking, speaking, contriving Substance as the Soul is; endow'd exactly with fuch Faculties, Power, and Dispositions as the various Necessities and Occasions of the World require from such a Creature? Why should not rather all the Acts, the Dispositions and Contrivances of such a Creature as Man, if made in a mechanical Way, and not contriv'd

⁽s) As we are not to accuse any fally; so far be it from me to detract from so great a Man as Monsieur Cartes was? Whose Principles, although many have perverted to atheistical Purposes, and whose Notions have, some of them, but an ill Aspect; yet I am unwilling to believe he was an Atheist; since in his Principia Philosophia, and other of his Works, he vindicates himself from this Charge; and frequently shews seemingly a great Respect for Religion: Besides, That many of his suspicious Opinions are capable of a favourable Interpretation, which will make them appear in a better Form: Thus when he discardeth final Causes from his Philosophy, it is not a Denial of them; but only excluding the Consideration of them, for the Sake of free philosophising; it being the Business of a Divine, rather than a Philosopher, to treat of them.

triv'd by God, have been the fame ? Particularly, Why should he not have hit upon all Contrivances of equal Use, early, as well as many Ages since ? Why not that Man have effected it, as well as this, some thousands of Years after? Why also should not all Nations, and all Ages (t), improve

(t) For Ages of Learning and Ignorance, we may compare the present, and some of the Ages before the Reformation. The last Century, and the few Years of this, have had the Happiness to be able to vie with any Age for the Number of learned Men of all Professions, and the Improvement made in all Arts and Sciences; too many, and too well known to

need a Specification.

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But for Ignorance, we may take the ninth Age, and fo down to the Reformation; even as low as Queen Elizabeth, although Learning began to flourish; yet we may guess how Matters stood, even among the Clergy, by her 53 Injunct. No. 1559. Such as are but mean Readers, shall peruse over before, once or twice, the Chapters and Homilies, to the Intent they may read to the better Understanding of the People, the more Encouragement of Godliness. Spar. Collect. p. 82. But this is nothing, in comparison to the Ages before, when the Monk said, Gracum non est legi; or as Espencaus more elegantly hath it, Grace nosse suspectum, Hebraice prope Hareticum. Which Suspicion, (faid the learned Hakewill,) Rhemigius, furely was not guilty of, in commenting upon diffamatus, I Theff. i. 8. who faith, that St. Paul somewhat improperly put that for divulgatus, not being aware that St. Paul wrote in Greek, and not in Latin. Nay, so great was their Ignorance, not only of Greek, but of Latin too, that a Priest baptiz'd in nomine Patria, & Filia, Spiritua sancta. Another fuing his Parishioners for not paving his Church, prov'd it from Fer. xvii. 18. Paveant illi, non paveam ego. Some Divines in Erasmus's Time, undertook to prove Hereticks ought to be burnt, because the Apostle said, Hareticum devita. Two Fryars disputing about a Plurality of Worlds, one prov'd it from Annon decem funt facti mundi? The other reply'd, Sed ubi funt novem? And notwithstanding their Service was read in Latin, yet so little was that understood, that an old Priest in Hen. VIII. read Mumpsimus Domine, for Sumpsimus: And being admonish'd of it, he said, he had done so for thirty Years, and would not leave his old Mumpsimus for their new Sumpsimus. Vid. Hakew. Apol. 3. c. 7. feet. 2. (11) There

Of Man's Invention. BOOK V.

in every Thing, as well as this, or that Age, or Nation (11) only? Why should the Greeks, the Arabians, the Persians, or the Agyptians of old, so far exceed those of the same Nations now? Why the Africans and Americans so generally ignorant and barbarous, and the Europens, for the most part, polite and cultivated, addicted to Arts and Learning? How could it come to pass, that the

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(u) There is (it feems) in Wits and Arts, as in all Things beside, a kind of circular Progress: They have their Birth, their Growth, their Flourishing, their Failing, their Fading; and within a while after, their Resurrection, and Reflourishing again. The Arts flourished for a long Time among the Perfians, the Chaldwans, the Ægyptians. -But afterwards the Grecians got the Start of them, and are now become as barbarous themselves, as formerly they esteemed all besides themselves to be. About the Birth of Christ, Learning began to flourish in Italy, and spread all over Christendom; till the Goths, Huns, and Vandals, ransacked the Libraries, and defaced almost all the Monuments of Antiquity: So that the Lamp of Learning feemed to be put out for near the Space of 1000 Years, till the first Manser, King of Africa and Spain, raised up, and spurred forward the Arabian Wits, by great Rewards and Encouragements. Afterwards Petrarch opened fuch Libraries as were undemolished, He was seconded by Boccace, and John of Ravenna, and soon after by Aretine, Philelphus, Valla, &c. And those were followed by Aneas Sylvius, Angelus Politianus, Hermolaus Barbarus, Marsilius Ficinus, and Joh. Picus of Mirandula. These were backed by Rud, Agricola, Reucline, Melanethon, Joach. Camerarius, Wolphlazius, Beat. Rhenanus, Almaines: By Erasmus of Rotterdam; Vives a Spaniard; Bembus, Sadoletus, Eugubinus, Italians: Turnebus, Muretus, Ramus, Pithaus, Budaus, Amict, Scaliger, Frenchmen; Sir Tho. More and Linaker, Englishmen. And about this Time, even those Northern Nations yielded their great Men; Denmark yielded Olaus Magnus, Holster, Tycho Brabe, and Hemingius; and Poland, Hosius, Frixius, and Crumerus. But to name the Worthies that followed thefe, down to the present Time, would be endless, and next to impossible. See therefore Hakewill's Apolog. 1. 3. c. 6. fect. 2. (w) Dr. 0

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(w) Dr. Gilbert, the most learned and accurate Writer on the Magnet, shews, That its Attractive Virtue was known as early as Plato and Aristotle; but its Direction was a Discovery of later Ages. He faith, Superiori ave 300 aut 400 labentibus annis, Motus Magneticus in Boream & Austrum repertus, aut ab heminibus rursus recognitus fuit. De Mag. l. I. c. I. But who the happy Inventer of this lucky Discovery was, is not known. There is some, not inconsiderable, Reason, to think our famous Countryman, Rog. Bacon, either discovered, or at least knew of it. But for its Use in Navigation, Dr. Gilbert saith, In regno Neapolitano Melphitani omnium primi (uti ferunt) pyxidem instruebant nauticam. - edocti à cive quodam Jol. Goia, A. D. 1300, ibid. If the Reader hath a mind to fee the Arguments for the Invention, being as old as Solomon's or Plantus's Time, or of much younger Date, he may confult Hakewill, ib. c. 10. fect. 4. or Purchas Pilgr. l. 1. c. 1. fect. 1.

As to the Magnetick Variation, Dr. Gilbert attributes the Discovery of it to Sebastian Cabott. And the Inclination, of Dipping of the Needle, was the Discovery of our ingenious Rob. Norman. And lastly, The Variation of the Variation, was first found out by the ingenious Mr. H. Gellibrand, Astr. Prof. of Gressam-Col. about 1634. Vid. Gellibr. Disc. Math. on the Variation of the Mag. Need. and its Variat. Anno 1635.

But fince that, the before-commended Dr. Halley, having formerly, in Philof. Trans. No. 148, and 195, given a probable Hypothesis of the Variation of the Compass, did in the Year 1700, undertake a long and hazardous Voyage, as far as the Ice near the South Pole, in order to examine his said Hypothesis, and to make a System of the Magnetical Variations: Which being soon after published, has been since abundantly consirmed by the French, as may be seen in several of the late Memoirs de Physique & de Mathematique, publish'd by the French Academie des Sciences.

To these Discoveries, I hope the Reader will excuse me, if I add one of my own, which I deduced some Years ago, from some magnetical Experiments and Observations I made; which Discovery I also acquainted our Royal Society with some time since, viz. That as the common, horizontal Needle is continually varying up and down, towards the E. and W. so is the Dipping-Needle varying up and down, towards or fromwards with the Zenith, with its Magnetick Tendency, describing a Circle round the Pole of the World, as I conceive, or some other Point. So that if we could procure a Needle

A Needle so nicely made, as to point exactly according to its Magnetick Direction, it would, in some certain Number of Years, describe a Circle, of about 13 gr. Radius round the Magnetick Poles Northerly and Southerly. This I have for several Years suspected, and have had some Reasons for it too, which I mentioned three or four Years ago at a Meeting of our Royal Society; but I have not yet been so happy to procure a tolerable good Dipping-Needle, or other proper one to my Mind, to bring the Thing to sufficient Test of Experience; as in a short Time I hope to do, having lately hit

upon a Contrivance that may do the Thing.

(x) It is uncertain who was the Inventer of the Art of Printing, every Historian ascribing the Honour thereof to his own City or Country. Accordingly, some ascribe the Invention of it to John Guttenburg, a Knight of Argentine, about 1440, and say, that Faustus was only his Assistant. Bertius ascribes it to Laurence John, of Haerlem, and saith, Fust or Fauft, Itole from him both his Art and Tools. And to name no more, some attribute it to John Fust or Faust, and Peter Schoeffer (called by Fuft, in some of his Imprimaturs, Pet, de Ger. nespem puer meus.) But there is now to be seen at Haerlen, a Book or two printed by Lan. Kofter, before any of these, with in 1430, and in 1432. (See Mr. Ellis's Letter to Dr. Tyson, in Phil. Trans. No. 286.) But be the first Inventer who it will, there is however great Reason to believe, the Art received great Improvements from Fauft, and his Son-in-Law Schoeffer, the latter being the Inventer of metalline Types, which were cut in Wood before, first in whole Blocks, and afterwards in fingle Types or Letters. See my learned Friend Mr. Wanley's Observations, in Philos. Trans. No. 288, and 310.

(y) Concerning the Antiquity and Invention of Clocks and Clock-Work, I refer the Reader to a little Book, called the Artificial Clock-Maker, Chap. 6. Where there is some Account of the Ancients Inventions in Clock-Work, as Archimedes's

Sphere, Crefibius's Clock, &c.

(z) The Invention of Telescopes, Hieron. Syrturus gives this Account of, Prodiit Anno 1609, Seu Genius, seu alter vir adhui incognitus, Hollandi specie, qui Middleburgi in Zelandia convenit fol. Lippersein— Justit perspicilla plura tam cava quam convexa, confici. Conditto die rediit, absolutum opus cupiens, atque ut statim habuit pre manibus, bina suscipiens, cavum scil. E convexum, unum & alterum

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naximander, Anaximenes, Posidonius, or other great Virtuoso's of the early Ages, whose Contrivances of various Engines, Spheres, Clepsydræ, and other curious Instruments are recorded (aa)? And why

oculo admovebat, & sensim dimovebat sive ut punëtum concursûs, sive ut artificis opus probaret, postea abiit. Artisex, ingenii minime expers, & novitatis curiosus capit idem sacere & imitari, &c. Vid. Mus.

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(aa) Among the curious Inventions of the Ancients, Archytat's Dove was much famed; of which Aul. Gellius gives this Account : Scripferunt Simulachrum Columba è ligno ab Archyta ratione quadam disciplinaque mechanica factum, volasse: Ita erat scilicet libramentis suspensum. & aura spiritus inclusa atque occulta concitum. Noct. Attic. l. 10. c. 12. The same eminent Pythagorean Philosopher (as Favorinus in Gellius calls him) is by Herace accounted a noble Geometrician too, Te maris & terra, numeroque carentis arena Mensorem Archyta. Among the rest of his nventions, Children's Rattles are ascribed to him. Aristotle calls hem 'Agyuts maalayn, Polit. 8. i. e. Archytas's Rattle. And Diogenianus, the Grammarian, gives the Reason of his Invenion, 'Agrute Thatay's int ray, &c. That Archytas's Rattle vas to quiet Children; for he having Children, contrived the Rattle, which he gave them to prevent their [tumbling, flasalevsoss] other Things about the House.

To these Contrivances of Archytas, we may add Regiomonanus's Wooden Eagle, which flew forth of the City aloft in the Air, met the Emperor a good Way off, coming towards it, and having saluted lim, return'd again, waiting on him to the City-Gates. Also his tron-Fly, which at a Feast flew forth of his Hands, and taking a Round, returned thither again. Vid. Hakewill, ub. supr. c. 10.

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As to other Inventions of the Ancients, such as of Leters, Brick and Tiles, and building Houses, with the Saw, Rule, and Plumber, the Lath, Augre, Glue, &c. also the naking Brass, Gold, and other Metals; the use of Shields, words, Bows and Arrows, Boots, and other Instruments of War; the Pipe, Harp, and other Musical Instruments; the building of Ships and Navigation, and many other Things besides; the Inventers of these (as reported by Ancient Heathen Authors) may be plentifully met with in Plint at, Hist. 1, 7. c. 56.

But

Of these Matters, no satisfactory Account can be given by any mechanical Hypothesis, or any other Way, without taking in the Superintendence of the Great Creator and Ruler of the World; who oftentimes doth manifest himself in some of the most considerable of those Works of Men, by some remarkable Transactions of his Providence, or by some great Revolution or other happening in the World thereupon. Of this I might in

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But in this Account of Pliny we may observe whence the Ancients (even the Romans themselves in some measure) had their Accounts of these Matters, viz. from the fabulous Greek, who were fond of ascribing every Thing to themselves. In Truth is (faith the most learned Bishop Stilling fleet) there is me thing in the World useful or beneficial to Mankind, but they have made a shift to find the Author of it among themselves. If we enquire after the Original of Agriculture, we are told of Ceres and Triptole mus; if of Pasturage, we are told of an Arcadian Pan; if of Wine, we presently hear of a Liber Pater; if of Iron Instruments, the who but Vulcan; if of Mufick, none like to Apollo. If we pro them then with the History of other Nations, they are as well provide here; if we enquire an Account of Europe, Afia, or Libya; for M first, we are told a fine Story of Cadmus's Sister; for the second Prometheus's Mother of that Name; and for the third, of a Dang ter of Epaphus. 'And fo the learned Author goes on with other particular Nations, which they boasted themselves to be the Founders of. Only the grave Athenians thought Scornt have any Father assigned them, their only Ambition was to be accounted Aborigines & genuini Terræ. But the Ignorance and Va nity of the Greek History, that learned Author hath fufficient ly refuted. Vid. Stilling. Orig. Sacr. Part 1. B. 1. C. 4.

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stance in the Invention of Printing (bb), succeeded first by a train of Learned Men, and the Revival of Learning, and foon after that by the Reformation, and the much greater Improvements of Learning at this Day. But the most considerable Instance I can give is, the Progress of Christianity, by means of the civilized Disposition, and large Extent of the Roman Empire. The latter of which, as it made way for Human Power; fo the former made way for our most excellent Religion into the Minds of Men. And so I hope, and earnestly pray, That the Omnipotent and All-wise Ruler of the World will transact the Affairs of our most Holy Religion, e'er it be long, in the Heathen World; that the great Improvements made in the last, and present Age, in Arts and Sciences, in Navigation and Commerce, may be a Means to transport our Religion, as well as Name, through all the Nations of the Earth. For we find that our Culture of the more polite and curious Sciences, and our great Improvements in even the Mechanick Arts, have already made a Way for us into some of the largest and farthest distant Nations of the Earth; particularly into the great Empire of China (cc).

(ce) The Chinese being much addicted to Judicial Astrology, are great Observers of the Heavens, and the Appearances in them. For which Purpose they have an Observatory

⁽bb) Whether Printing was invented in 1440, as many imagine, or was fooner practifed, in 1430, or 1432, as Mr. Elii's Account of the Dutch Inscription in Phil. Trans. No. 286. doth import; it is however manifest, how great an Instuence (as it was natural) this Invention had in the promoting of Learning soon afterwards, mentioned before in Note (x). After which followed the Reformation about the Year 1517.

And now, before I quit this Subject, I cannot but make one Remark, by way of practical Inference, from what has been last said; and that is, Since it appears that the Souls of Men are ordered, disposed and actuated by God, even in secular, as well as spiritual Christian Acts; a Duty ariseth thence on every Man, to pursue the Ends, and anfwer all the Defigns of the Divine Providence, in bestowing his Gifts and Graces upon him. Men are ready to imagine their Wit, Learning, Genius, Riches, Authority, and fuch like, to be Works of Nature, Things of Course, or owing to their own Diligence, Subtilty, or fome Secondary Causes: that they are Masters of them, and at Liberty to use them as they please, to gratifie their Lust or Humour, and fatisfie their depraved Appetites. But it is evident, That these Things are the Gifts of God, they are so many Talents entrusted with us by the Infinite Lord of the World, a Stewardship, a Trust reposed in us; for which we must give an Account at the Day when our Lord shall

at Pekin, and five Mathematicians appointed to watch every Night; four towards the four Quarters of the World, and one towards the Zenith, that nothing may escape their Observation. Which Observations are the next Morning brought to an Office to be registred. But notwithstanding this their Diligence for many Ages, and that the Emperor hath kept in his Service above 100 Persons to regulate the Kalendar, yet are they such mean Astronomers, that they owe the Regulation of their Kalendar, the Exactness in calculating Eclipses, &c. to the Europeans; which renders the European Mathematicians so acceptable to the Emperor, that Father Verbiest, and divers others, were not only made Principals in the Observatory, but put into Places of great Trust in the Empire, and had the greatest Honours paid them at their Deaths. Vid. La Comte Mem. of China. Letter 2d. &c.

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Ou God, bide exhor the G idle, XEPLOP ginal Gift t tion, he gar ling, l ted to on of the G Serva any C Botar fay, a of Go which disch lity, to us. xvi. thou may

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CHAP. I. Of Man's Invention. 287

call; according to the parabolical Representation of this Matter by our Blessed Saviour. Matt.

XXV. 14.

Our Duty then is not to abuse these Gifts of God, not to neglect the Gift that is in us, not to hide our Talent in the Earth; but as St. Paul exhorteth Timothy, 2 Tim. i. 6. we must fir up the Gift of God which is in us, and not let it lie idle, concealed or dead; but we must ara (arupe ir +) yapropa, blow it up, and enkindle it, as the Original imports; we must improve and employ our Gift to the Glory of the Giver; or in that Ministration, that Use and Service of the World, for which he gave it. Our Stewardship, our Craft, our Calling, be it that of Ambassadors of Heaven, committed to us, as 'twas to Timothy, (dd) by the laying on of Hands; or be it the more fecular Bufiness of the Gentleman, Tradesman, Mechanick, or only Servant; nay, our good Genius, our Propensity to any Good, as suppose to History, Mathematicks, Botany, Natural Philosophy, Mechanicks, &c. I fay, all these Occupations, in which the Providence of God hath engaged Men, all the Inclinations to which his Spirit hath disposed them, ought to be discharged with that Diligence, that Care and Fidelity, that our Great Lord and Master may not say to us, as was faid to the unfaithful Steward, Luke xvi. 2. Give an Account of thy Stewardship, for thou mayest be no longer Steward; but that he may fay, as 'tis in the Parable before-cited, Matt. XXV. 21. Well done thou good and faithful Servant, thou hast been faithful over a few Things, I will

⁽dd) 1 Tim. iv. 14. 2 Tim. i. 6.

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I will make thee Ruler over many Things, enter thou into the Foy of thy Lord. Since now the Case is thus, let us be perswaded to follow Solomon's Advice, Eccles. ix. 10. Whatsoever thy Hand sindeth to do, do it with thy Might (ee): "Lay hold on every Occasion that presents it self, and improve it with the utmost Diligence; because now is the Time of Action, both in the "Employments of the Body, and of the Mind; now is the Season of studying either Arts and "Sciences, or Wisdom and Virtue, for which thou "wilt have no Opportunities in the Place whither thou art going in the other World. For there is no Work, nor Device, nor Knowledge, nor "Wisdom in the Grave whither thou goest."

(ee) Bishop Patrick in loc.

CHAP. II.

Of Man's Body, particularly its Posture.

Having thus, as briefly as well I could, surveyed the Soul, let us next take a View of Mania Body. Now here we have such a Multiplicity of the most exquisite Workmanship, and of the best Contrivance, that if we should strictly Survey the Body from Head to Foot, and search only into the known Parts (and many more lie undiscovered) we should find too large and tedious a Task to be dispatched. I shall therefore have Time only to take a transient and general Kind of View of this admirable Machine, and that somewhat briefly too, being

being prevented by others, particularly two excellent Authors of our own (a), who have done it on

the same Account as my self. And the

I. Thing that presents it self to our View, is the Erest Posture (b) of Man's Body; which is far the most, if not the only commodious Posture for a Rational Creature, for him that hath Dominion over the other Creatures, for one that can invent useful Things, and practise curious Arts. For without this erect Posture, he could not have readily turned himself to every Business, and on every Occasion. His Hand (c) particularly could

(a) Mr. Ray, in his Wisdom of God manifested in the Works of Creation, Part 2. And Dr. Cockburn's Essays on Faith, Part 1. Essay 5.

(b) Ad hanc providentiam Natura tam diligentem [of which he had been before speaking] tamque solertem adjungi multa possunt, è quibus intelligatur, quanta res hominibus à Deo, quamque eximia tributa sunt: qui primum eos humo excitatos, celsos e erectos constituit, nt Deorum cognitionem, cœlum intuentes, capere possunt. Sunt enim è terra homines non ut incola, atque habitatores, sed quasi spectatores superarum rerum, atque cœlestium, quarum spectaculum ad nullum aliud genus animantium pertinet. Cic. de Nat. Deor. 1. 2. c. 56.

(c) Ut autem sapientissimum animalium est Homo, sie & Manus sunt organa sapienti animali convenientia. Nam enim quia Manus habuit, propterea est sapientissimum, ut Anaxagoras dicebat; sed quia sapientissimum erat, propter hoc Manus habuit, ut rectissime censuit Aristoteles. Non enim Manus upsa hominem artes docuerunt, sed Ratio. Manus autem ipsa sunt artium organa, &c. Galen. de Us. Part, l. 1. c. 3. After which, in the rest of this first Book, and Part of the second, he considers the Particulars of the Hand, in order to enquire, as he saith, Ch. 5. Numeam omnino Constitutionem habeat [manus] quià meliorem aliam habere non potuit.

Of this Part, (and indeed of the other Parts of Human Bodies) he gives so good an Account, that I confess I could not but admire the Skill of that ingenious and famed Heathen. For an Example, (because it is a little out of the Way,) Ishall pitch upon his Account of the different Length of the Fingers, Lib. 1. Cap. 24. The Reason of this Mechanical Confession of the State of the S

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not have been in so great a Readiness to execute the Commands of the Will, and Dictates of the Soul. His Eyes would have been the most prone, and incommodiously situated of all Animals; but by this Situation, he can cast his Eyes upwards, downwards, and round about him; he hath a Glorious Hemisphere of the Heavens (d), and an ample Horizon on Earth (e), to entertain his Eye.

And

nism, he faith is, That the Tops of the Fingers may come to an Equality, Cum magnas aliquas moles in circuitu comprehendunt & cum in seipsis humidum vel parvum corpus continere conantur. -Apparent verò in unam circuli circumferentiam convenire Digiti quinque in actionibus bujusmodi maxime quando exquisite sphericum corpus comprehendunt. And this Evenness of the Fingers Ends. in grasping sphærical, and other round Bodies, he truly enough faith, makes the Hold the firmer. And it feems a noble and pious Defign he had in fo strictly furveying the Parts of Man's Body, which take in his own translated Words, Cum multa namque effet apud veteres, tam Medicos, quan Philosophos de utilitate particularum dissensio (quidam enim corpora nostra nullius gratiù esse facta existimant, nullaque omnino arte : alii autem & alicujus gratia, & artificiose, ____) primum quidem tante hujus dissensionis neringer invenire ftudui : deinde verd & unam. aliquam universalem methodum constituere, qua singularum partium corporis. & corum que illis accidunt utilitatem invenire possemus. cap. 8.

(d) Pronaque cum spectant animalia catera terram, Os Homini sublime dedit, columque tueri Fussit. & erectos ad sidera tollere vultus.

Ovid. Metam. l. 1. car. 84.

(e) If any should be so curious, to desire to know how far a Man's Prospect reacheth, by Means of the Height of his Eye, supposing the Earth was an uninterrupted Globe; the Method is a common Case of right-angled plain Triangles, where two Sides, and an opposite Angle are given: Thus in Fig. 4. A H B is the Surface, or a great Circle of the Terraqueous Globe; C the Center, HC its Semidiameter, E the Height of the Eye; and forasmuch as H E is a Tangent, therefore the Angle at H is a right Angle: So that there are given H C 398,386 Miles, or 21034781 English Feet, (according to Book II. Chap. 2. Note (a);) C E the

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fame Length with the Height of the Eye, on the Mast of a Ship, or at only a Man's Height, &c. added to it; and EHC the opposite Right Angle. By which three Parts given, it is easy to find all the other Parts of the Triangle. And first, The Angle at C, in order to find the Side HE, the Proportion is, as the Side CE, to the Angle at H; so the Side HC, to the Angle at E, which being substracted out of 90 gr. the Remainder is the Angle at C. And then, as the Angle at E, is to its opposite Side # C, or else as the Angle at H is to its opposite Side C E; so the Angle at C, to its opposite Side E H, the visible Horizon. Or the Labour may be shortned, by adding together the Logarithm of the Sum of the two given Sides, and the Logarithm of their Difference; the Half of which two Logarithms, is the Logarithm of the Side requir'd, nearly. For an Example, We will take the two Sides in Yards, by Reason scarce any Table of Logarithms will ferve us farther. The Semidiameter of the Earth is 7011594 Yards; the Height of the Eye is two Yards more, the Sum of both Sides, is 14023190.

Logar, of which Sum is,	0,3010300
Sum of both Logar	7,4478768
The half Sum,	3,7239384

is the Logarithm of 5296 Yards = three Miles, which is the Length of the Line E H, or Distance the Eye can reach at

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This would be the Distance, on a perfect Globe, did the visual Rays come to the Eye in a strait Line; but by Means of the Rarefractions of the Atmosphere, distant Objects on the Horizon, appear higher than really they are, and may be seen at a greater Distance, especially on the Sea; which is a Matter of great Use, especially to discover at Sea the Land, Rocks, Esc. and it is a great Ast of the Divine Providence, in the Contrivance and Convenience of the Atmosphere, which by this Means enlargeth the visible Horizon, and is all one, as if the Terraqueous Globe was much larger than really it is. As to the Height of the Apparent above the true Level; or, how much distant Objects are raised by the Refractions, the ingenious and accurate Gentlemen of the French Academy Royal, have given us a Table in their Measure of the Earth, Art, 12.

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And as this Erection of Man's Body is the most compleat Posture for him; so if we Survey the Provision made for it, we find all done with manifest Defign, the utmost Art and Skill being employ'd To pass by the particular Conformation of many of the Parts, the Ligaments and Fastnings to answer this Posture; as the Fastning, for Instance. of the Pericordium to the Diaphragm, (which is peculiar to Man (f); I fay, passing by a deal of this Nature, manifesting this Posture to be an A& of Defign,) let us stop a little at the curious Fabrick of the Bones, those Pillars of the Body. And how artificially do we find them made, how curiously plac'd from the Head to Foot! The Vertebra of the Neck and Back-bone (g), made short and complanated, and firmly braced with Muscles and Tendons, for easy Incurvations of the Body; but withal for greater Strength, to Support the Body's own Weight, together with other additional Weights it may have Occasion to bear. The Thighbones and Legs long, and strong, and every Way well fitted for the Motion of the Body. The Feet accommodated with a great Number of Bones, curiously and firmly tack'd together, (to which must be added the Ministry of the Muscles (b), to an-

(f) See Book VI. Chap. 5. Note (g). (g) See Book IV. Chap. 8. Note (c).

⁽b) The Mechanism of the Foot, would appear to be wonderful, if I should descend to a Description of all its Parts; but that would be too long for these Notes; therefore a brief Account, (most of which I owe to the beforecommended Mr. Cheselden,) may serve for a Sample: In the sirst Place, it is necessary the Foot should be concave, to enable us to stand firm, and that the Nerves and Blood-Vessels may be free from Compression when we stand or walk.

fwer all the Motions of the Legs and Thighs, and at the fame Time to keep the Body upright, and prevent its falling, by readily affifting against every Vacillation thereof, and with easy and ready Touches keeping the Line of Innexion, and Centre of Gravity, in due Place and Posture (i).

And as the Bones are admirably adapted to prop; fo all the Parts of the Body are as incomparably plac'd to poise it. Not one Side too heavy for the other; but all in nice Æquipoise: The Shoulders, Arms, and Side æquilibrated on one Part; on the other Part the Viscera of the Belly counterpois'd with the Weight of the scapular Part, and that useful Cushion of Flesh behind.

And lastly, To all this we may add the wonderful Concurrence, and Ministry, of the prodigious Number and Variety of Muscles, plac'd throughout the Body for this Service; that they should so readily

(i) It is very well worth while to compare here what Borelli faith, de motu Animal. Par. 1. cap. 18. De statione Animal. Prop. 132, &c. To which I refer the Reader, it being too long to recite here.

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walk. In order hereunto, the long Flexors of the Toes cross one another at the Bottom of the Foot, in the Form of a St. Andrew's Cross, to incline the leffer Toes towards the great One, and the great One towards the leffer. The foot Flexors are chiefly concern'd in drawing the Toes towards the Heel. The transversalis Pedis draws the Outsides of the Foot towards each other; and by being inserted into one of the fefamoid Bones of the great Toe, diverts the Power of the abdustor Muscle, falsly so called, and makes it become a Flexor. And lastly, The peronaus Longus runs round the outer Ankle, and obliquely forwards cross the Bottom of the Foot, and at once helps to extend the Tarsus, to constrict the Foot, and to direct the Power of the other Extensors towards the Ball of the great Toe: Hence the Loss of the great Toe, is more than of all the other Toes. See also Mr. Cowper's Anat. Tab. 28, Sec.

readily answer to every Posture; and comply with every Motion thereof, without any previous Thought or Reslex act, so that (as the excellent Borelli (k) saith, "It is worthy of Admiration, that in so great a Variety of Motions, as Running, Leaping, and Dancing, Nature's Laws of Aqualibration should always be observed; and when nese glected, or wilfully transgressed, that the Body must necessarily and immediately tumble down.

(k) Borel, ibid, Prop. 142,

CHAP. III.

Of the Figure and Shape of Man's Body.

THE Figure and Shape of Man's Body, is the most commodious that could possibly be invented for fuch an Animal; the most agreeable to his Motion, to his Labours, and all his Occasions. For had he been a rational Reptile, he could not have moved from Place to Place fast enough for his Bufiness, nor indeed have done any almost. Had he been a rational Quadrupede, among other Things, he had lost the Benefit of his Hands, those noble Instruments of the most useful Performances of the Body. Had he been made a Bird, besides many other great Inconveniencies, those before-mentioned of his Flying would have been some. In a Word, any other Shape of Body, but that which the Allwife Creator hath given Man, would have been as incommodious, as any Posture but that of erect; it would have rendered him more Helpless, or have put JETOS ()

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put it in his Power to have been more Pernicious, or deprived him of Ten-thousand Benefits, or Pleafures, or Conveniences, which his present Figure capacitates him for.

CHAP. IV.

Of the Stature and Size of Man's Body.

▲ S in the Figure, fo in the Stature and Size of Man's Body, we have another manifest Indication of excellent Defign. Not too Pygmcan (a), not too Gigantick (b), either of which Sizes would in some Particular or other, have been incommodious to Himself, or to his Business, or to the rest of his Fellow-Creatures. Too Pygmean would have rendered him too puny a Lord of the Creation; too impotent, and unfit to manage the inferiour Creatures; would have exposed him to the Assaults of the weakest Animals, to the ravening Appetite of voracious Birds, and have put him in the Way, and endangered his being trodden in the Dirt by the larger Animals. He would have been also too weak for his Business, unable to carry Burdens; and in a Word, to transact the greater Part of his Labours and Concerns.

⁽a) What is here urged about the Size of Man's Body, may answer one of Lucretius's Reasons, why Nil ex nihilo gignitur. His Argument is.

Denique cur Homines tantos natura parare Non potuit, pedibus qui pontum per vada possent Transire, & magnos manibus divellere monteis?

⁽b) Haud facile fit ut quisquam & ingentes corporis vires, & ingepium subtile habeat, Diodor. Sic. 1. 17.

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And on the other Hand, had Man's Body been made too monstrously strong, too enormously Gigantick (c), it would have rendered him a dange-

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(c) Altho' we read of Giants before Noah's Flood, Gen, vi. 4. and more plainly afterwards in Numb. xiii. 33. Yet there is great Reason to think the Size of Man was always the fame from the Creation. For as to the Nephilim, or Giants, in Gen, vi. the Ancients vary about them; some taking them for great Atheists, and Monsters of Impiety, Rapine, Tyranny, and all Wickedness, as well as of monstrous Stature, according as indeed the Hebrew Signification allows.

And as for the Nephilim, in Numb, xiii. which were evidently Men of a Gigantick Size, it must be considered, that it is very probable, the Fears and Discontentments of the Spies might

add fomewhat thereunto.

But be the Matter as it will, it is very manifest, that in both these Places, Giants are spoken of as Rarities, and Wonders of the Age, not of the common Stature. And fuch Instances we have had in all Ages; excepting some fabulous Relations; fuch as I take to be that of Theutobecchus, who is faid to have been dug up, Anno 1613, and to have been higher than the Trophies, and 26 Feet long; and no better I suppose the Giants to have been that Ol. Magnus gives an Account of in his 5th Book, fuch as Harthen, and Starchater, among the Men; and among the Women, Reperta est (faith he) puellain capite vulnerata, ac mortua, induta chlamyde purpurea, longitudinis cubitorum 50, latitudinis inter humeros quatuor. Ol. Mag. Hift, 1. 5. C. 2.

But as for the more credible Relations of Goliath (whose Height was 6 Cubits and a Span, I Sam. xvii. 4. which according to the late curious and learned Lord Bishop of Peterlorough, is somewhat above 11 Feet English, vid. Bishop Cumberland of Jewish Weights and Measures) of Maximinus the Emperor, who was 9 Feet high, and others in Augustus, and other Reigns, of about the same Height: To which we may add, the Dimensions of a Skeleton, dug up lately in the Place of a Roman Camp near St. Albans, by an Urn, inferibed, Marcus Antoninus; of which an Account is given by Mr. Chefelden, who judgeth by the Dimensions of the Bones, that the Person was 8 Feet high. Vid. Philof. Trans. No. 333. These antique Examples and Relations, I say, we can match, yea, out-do, with modern Examples; of which we have diyers in J. Ludolph, Comment. in Hift. Athiop. 1. 1. c. 2. fest. 22.

Magus, Conringius, Dr. Hakewill, and others. Which latter relates from Nannez, of Porters and Archers belonging to the Emperor of China, of 15 Feet high; and others from Purchas, of 10 and 12 Feet high, and more. See the learned Author's Apolog. p. 208.

These indeed exceed what I have seen in England; but in 1684, I my self measur'd an Iris Youth, said to be not 19 Years old, who was 7 Feet near 8 Inches; and in 1697, a Wo-

man who was 7 Feet 3 Inches in Height.

But for the ordinary Size of Mankind, in all Probability, it was always (as I faid) the fame, as may appear from the Monuments, Mummies, and other ancient Evidences to be feen at this Day. The most ancient Monument at this Day, I presume, is that of Cheops, in the first and fairest Pyramid of Ægypt; which was, no doubt, made of Capacity every Way sufficient to hold the Body of so great a Person as was intended to be laid up in it. But this we find, by the nice Measures of our curious Mr. Greaves, hardly to exceed our common Coffins. The hollow Part within (faith he) is in Length only 6,488 Feet, and in Breadth but 2,218 Feet: The Depth 2,860 Feet. A narrow Space, yet large enough to contain a most potent and dreadful Monarch, being dead; to whom living, all Ægypt was too streight and narrow a Circuit. By these Dimensions, and by such other Observations, as have been taken by me from several embalmed Bodies in Ægypt, we may conclude there is no decay in Nature (though the Question is as old as Homer, but that the Men of this Age are of the same Stuture they were near 3000 Years ago. Vid. Greaves of the Pyr. in 1638, in Ray's Collect. of Trav. Tom. 1. p. 118.

To this more ancient, we may add others of a later Date. Of which take these, among others, from the curious and learned Hakewill. The Tombs at Pisa, that are some thousand Years old, are not longer than ours; so is Athelstane's in Malmesbury-Church; so Sebba's in St. Paul's, of the Year 693;

fo Etheldred's, &c. Apol. 216, &c.

The same Evidence we have also from the Armour, Shields, Vessels, and other Utensils dug up at this Day. The Brass Helmet dug up at Metaurum, which was not doubted to have been lest there at the Overthrow of Assurbal, will sit one of

our Men at this Day.

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22. 1gus, Nay, befides all this, probably we have some more certain Evidence. Augustus was 5 Feet 9 Inches high, which was the just Measure of our famous Queen Elizabeth, who exceed his Height 2 Inches, if proper Allowance be made for the Difference between the Roman and our Foot. Vid. Hakew. ib. p. 215.

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rous Tyrant in the World, too strong (d) in some Respects, even for his own Kind, as well as the other Creatures. Locks and Doors might per-

(d) To the Stature of Men in the foregoing Note, we may add some Remarks about their unusual Strength. That of Sampson (who is not faid to have exceeded other Men in Stature, as he did in Strength) is well known. So of old. Hector, Diomedes, Hercules, and Ajax, are famed; and fince them many others; for which I shall feek no farther than the before-commended Hakewill, who by his great and curious Learning, hath often most of the Examples that are to be met with on all his Subjects he undertakes. Of the After-Ages he names C. Marius, Maximinus, Aurelian, Scander. berge, Bardesin, Tamerlane, Siska, and Hunniades. Anno 1529, Klunher, Provost of the great Church at Misnia, carry'd a Pipe of Wine out of the Cellar, and laid it in the Cart, Mayolus saw one hold a Marble Pillar in his Hand 3 Feet long, and I Foot diameter, which he tos'd up in the Air, and catched again, as if it were a Ball. Another of Mantua, and a little Man, named Rodamas, could break a Cable, &. Ernando Burg, fetched up Stairs an Ass laden with Wood, and threw both into the Fire. At Constantinople, Anno 1582, one lifted a Piece of Wood, that twelve Men could scarce raise; then lying along, he bare a Stone that ten Men could but just roll to him. G. of Fronsberge, Baron Mindlehaim, could raife a Man off his Seat, with only his middle Finger; ftop an Horse in his full Career; and shove a Cannon out of its Place. Cardan faw a Man dance with two Men in his Arms, two on his Shoulders, and one on his Neck. Patacoua, Captain of the Coffacks, could tear an Horse-Shoe (and if I mistake not, the same is reported of the present King Augustus of Poland.) A Gigantick Woman of the Netherlands could lift a Barrel of Hamburgh Beer. Mr. Carew had a Tenant that could carry a Butt's Length, 6 Bushels of Wheaten Meal (of 15 Gallons Measure) with the Lubber, the Miller of 24 Years of Age, on the top of it. And J. Roman of the same County, could carry the Carcass of an Ox. Vid. Hakewill, ib. p. 2,38.

Viros aliquet moderna memoria tam à mineralibus, quam aliis Seuthia & Gothia provinciis adducere congruit, tanta fertitudine praditos, ut quisque eorum in humeros sublevatum Equum, vel Boven maximum, imo vas ferri 600, 800, aut 1000 librarum (quale & aliqua Puella levare possunt,) ad plura, stadia portaret, Ol. Mag.

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haps have been made of sufficient Strength to have barricaded our Houses; and Walls, and Ramparts might perhaps have been made strong enough to have fenced our Cities. But these Things could not have been without a great and inconvenient Expence of Room, Materials, and fuch Necessaries, as fuch vast Structures and Uses would have occasioned; more perhaps than the World could have afforded to all Ages and Places. But let us take the Descant of a good Naturalist and Physician on the Case (e). " Had Man been a Dwarf " (said he) he had scarce been a Reasonable Crea-" ture. For he must then have had a Jolt Head; " fo there would not have been Body and Blood " enough to supply his Brain with Spirits; or he " must have had a small Head, answerable to his "Body, and so there would not have been Brain " enough for his Business---Or had the Species of " Mankind been Gigantick, he could not have " been so commodiously supplied with Food. For " there would not have been Flesh enough of the " best edible Beasts, to serve his Turn. And if "Beafts had been made answerably bigger, there " would not have been Grass enough. And so he goeth on. And a little after, "There would not "have been the same Use and Discovery of his "Reason; in that he would have done many "Things by mere Strength, for which he is now " put to invent innumerable Engines --- Neither " could he have used an Horse, nor divers other " Creatures, But being of a middle Bulk, he is " fitted to manage and use them all, For (faith

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"he) no other Cause can be affigured, why a Man was not made five or ten Times bigger, but his Relation to the rest of the Universe". Thus far our curious Author.

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CHAP. V.

Of the Structure of the Parts of Man's Body.

Having thus taken a View of the Posture, Shape, and Size of Man's Body, let us in this Chapter survey the Structure of its Parts. But here we have so large a Prospect, that it would be endless to proceed upon Particulars. It must suffice therefore to take Notice, in general only, how artificially every Part of our Body is made. No Botch, no Blunder, no unnecessary Apparatus (or in other Words) no Signs of Chance (a); but every Thing curious, orderly, and performed in the shortest and best Method, and adapted to the most compendious Use. What one Part is there throughout the whole Body, but what is

⁽a) It is manifestly an Argument of Design, That in the Bodies of different Animals, there is an Agreement of the Parts, so far as the Occasions and Offices agree; but a Difference of those, where there is a Difference of these. In an Human Body are many Parts agreeing with those of a Dog for Instance; but in his Forehead, Fingers, Hand, Instruments of Speech, and many other Parts, there are Muscles, and other Members which are not in a Dog. And so contrariwise in a Dog, which are not in a Man. If the Reader is minded to see what particular Muscles are in a Man, that are not in a Dog; or in a Dog, that are not in an Human Body, let him consult the curious and accurate Anatomist Dr. Douglass's Myogr. compar.

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composed of the fittest Matter for that Part; made of the most proper Strength and Texture; shaped in the compleatest Form; and in a Word, accouter'd with every Thing necessary for its Motion, Office, Nourishment, Guard, and what not! What fo commodious a Structure and Texture could have been given to the Bones, for Instance, to make them firm and ftrong, and withal light, as that which every Bone in the Body hath? Who could have shaped them so nicely to every Use, and adapted them to every Part, made them of fuch just Lengths, given them such due Sizes and Shapes, chanelled, hollowed, headed, lubricated, and every other Thing ministring, in the best and most compendious Manner to their several Places and Uses? What a Glorious Collection and Combination have we also of the most exquisite Workmanship and Contrivance in the Eye, in the Ear, in the Hand (b), in the Foot (c), in the Lungs, and other Parts already mention'd? What an Abridgment of Art, what.

(b) Galen having described the Muscles, Tendons, and other Parts of the Fingers, and their Motions, cries out, Considera igitur etiam his mirabilem CREATORIS sapientiam! De Us. Part. 1. 1. c. 18.

⁽c) And not only in the Hand, but in his Account of the Foot (L. 3.) he frequently takes Notice of what he calls Artem, Providentiam & Sapientiam Conditoris. As Ch. 13. An igitur non aquum est hic quoque admirari Providentiam Conditoris, qui ad utrumque usum, etsi certè contrarium, exastè convenientes & consentientes invicem fabricatus est totius membri [tibiæ] particulas? And at the end of the Chap. Quod si omnia que ipsarum sunt partium mente immutaverinus, neque invenerimus positionem aliam meliorem ea quam nunc sortita sunt, neque siguram, neque magnitudinem, neque connexionem, neque (ut paucis omnia complettar) aliud quidquam eorum, qua corporibus necessario insunt, persettissimam pronunciare oportet, & undique rettè constitutam prasentem ejus constructionem. The like also concludes, Ch. 15.

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what a Variety of Uses (d), hath Nature laid upon that one Member of the Tongue, the grand Instrument of Taste, the faithful Judge, the Centinel, the Watchman of all our Nourishment, the artful Modulator of our Voice, the necessary Servant of Mastication, Swallowing, Sucking, and a great deal besides? But I must desist from proceeding upon Particulars, finding I am fallen upon what I

propos'd to avoid.

And therefore for a Close of this Chapter, I shall only add Part of a Letter I receiv'd from the before-commended very curious and ingenious Physician Dr. Tancred Robinson: What, (faith he.) can possibly be better contrived for animal Motion and Life, than the quick Circulation of the Blood and Fluids, which run out of Sight in capillary Veffels, and very minute Duts, without Impediment, (except in some Diseases,) being all directed to their peculiar Glands and Chanels, for the different Secretion, sensible and insensible; whereof the last is far the greatest in Quantity and Effects, as to Health and Sickness, acute Distempers frequently arising from a Diminution of Transpiration, through the cutaneous Chimneys, and some chronical Ones from an Augmentation: Whereas, Obstructions in the Liver, Pancreas, and other Glands, may only cause a Schirrus, a Faundice, an Ague, a Dropfy, or other flow Difeases. So an

Increase

⁽d) At enim Opificis industrit maximum est indicium (quemadmodum ante sapenumero jam diximus) iis qua ad alium usum suemunt comparata, ad alias quoque utilitates abuti, neque laborare ut singulis utilitatibus singulas faciat proprias particulas. Galen. ub. supr. l. 9. c. 5.

Increase of that Secretion may accompany the general Colloquations, as in Fluxes, betlick Sweats and Coughs, Diabetes, and other Consumptions. What a mighty Contrivance is there to preserve these due Secretions from the Blood. (on which Life so much depends,) by frequent Attritions, and Communications of the Fluids in their Passage through the Heart, the Lungs, and the whole System of the Muscles? What Meanders and Contortions of Vessels, in the Organs of Separation? And, What a Concourse of Elastick Bodies from the Air, to supply the Springs, and continual Motions of some Parts, not only in Sleep, and Rest; but in long violent Exercises of the Muscles? Whose Force drive the Fluids round in a wonderful rapid Circulation through the minutest Tubes, assisted by the constant Pabulum of the Atmosphere, and their own Elastick Fibres, which impress that Velocity on the Fluids.

Now I have mention'd some Uses of the Air, in carrying on several Functions in animal Bodies; I may add the Share it hath in all the Digestions of the solid and sluid Parts. For when this System of Air comes, by Divine Permittance, to be corrupted with poysonous, acrimonious Steams, either from the Earth, from Merchandise, or insected Bodies, What Havock is made in all the Operations of living Creatures? The Parts gangrene, and mortify under Carbuncles, and other Tokens: Indeed, the whole Animal Oeconomy is ruin'd; of such Importance is the Air to all the Parts of it. Thus

my learned Friend.

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CHAP. VI.

Of the Placing the Parts of Man's Body. .

IN this Chapter, I propose to consider the Lodg. ment of the curious Parts of Man's Body, which is no less admirable than the Parts themselves, all fet in the most convenient Places of the Body, to minister to their own several Uses and Purposes, and affift, and mutually to help one another. Where could those faithful Watchmen the Eye, the Ear, the Tongue, be so commodiously placed as in the upper Part of the Building? Where could we, throughout the Body, find fo proper a Part to lodge four of the Five Senses, as in the Head (a). near the Brain (b), the Common Sensory, a Place well guarded, and of little other Use than to bea Seat to those Senses? And, How could we lodge the fifth Sense, that of Touching otherwise (c), than to disperse it to all Parts of the Body? Where

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(e) See Book IV. Chap. 6. Note (c).

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⁽a) Sensus, interpretes ac nuncii rerum, in capite, tanquam in arc, mirifice ad usus necessarios & facti, & collocati sunt. Nam oculi tanquam speculatores, altissimum locum obtinent; ex quo plurima conspicientes, sungantur suo munere. Et aures cum sonum recipere debeant, qui natura in sublime fertur; recte in illis corporum partibus collocate suns. Cicer. de Nat. Deor. 1. 2. c. 56. ubi plura de cæteris Sensibus.

⁽b) Galen well observes, That the Nerves ministring to Motion, are hard and firm, to be less subject to Injury; but those ministring to Sense, are soft and tender; and that for this Reason it is, that four of the Five Senses are lodged so near the Brain, viz. partly to partake of the Brain's Softness and Tenderness, and partly for the Sake of the strong Guard of the Skull. Vid. Gal. de Us. Part. 1. 8. c. 5, 6:

CHAP. VI. Parts of Man's Body. 305

could we plant the Hand (d), but just where it is, to be ready at every Turn, on all Occasions of Help and Defence, of Motion, Action, and every of its useful Services? Where could we set the Legs and Feet, but where they are, to bear up, and handsomely to carry about the Body? Where could we lodge the Heart, to labour about the Whole Mass of Blood, but in, or near the Centre of the Body (e)? Where could we find Room for that noble Engine to play freely in ? Where could we fo well guard it against external Harms, as it is in that very Place in which it is lodg'd and fecur'd? Where could we more commodiously place, than in the Thorax and Belly, the useful Viscera of those Parts, so as not to swag, and jog, and overfet the Body, and yet to minister so harmoniously, as they do, to all the feveral Uses of Concoction, Sanguification, the Separation of various Ferments from the Blood, for the great Uses of Nature, and to make Discharges of what is useless, or would be burdensome or pernicious to the Body (f)? How could we plant the curious and great Variety of Bones, and of Muscles, of all Sorts and Sizes, necessary, as I have said, to the Support, and every Motion of the Body? Where could we lodge all the Arteries and Veins, to convey Nourishment; and

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(d) Quâm verò aptas, quamque multarum artium ministras Manus natura homini dedit? The Particulars of which, enumerated by him, see in Cio. ubs supra, c. 60:

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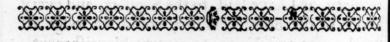
(g) Com-

⁽e) See Book VI. Chap. 5.

(f) Ut in adificits Architecti avertunt ab oculis & naribus dominorum ea, que profluentia necessariò tetri essent aliquid habitura; sic natura res similes (scil. excrementa) procul admandavit à sensibus. Cicer: de Nat. Deor. 1. 2. c. 56.

Provisions against Evils. BOOK V. and the Nerves, Sensation throughout the Body? Where, I fay, could we lodge all these Implements of the Body, to perform their feveral Offices? How could we fecure and guard them fo well, as in the very Places, and in the felt fame Manner in which they are already plac'd in the Body? And laftly, to name no more, What Covering, what Fence could we find out for the whole Body, better than that of Nature's own providing, the Skin (g)? How could we shape it to, or brace it about every Part better, either for Convenience or Ornament? What better Texture could we give it, which although less obdurate and firm, than that of some other Animals; vet is so much the more sensible of every touch, and more compliant with every Motion? And being eafily defenfible by the Power of Man's Reason and Art, is therefore much the properest Tegument for a Reafonable Creature.

⁽g) Compare here Galen's Observations de Us. Part. 1. 11.
c. 15. Also 1. 2. c. 6. See also Cowper Anat. where in Tab. 4.
are very elegant Cuts of the Skin in divers Parts of the Body,
drawn from microscopical Views; as also of the papilla Pyramidales, the sudoreserous Glands and Vessels, the Hairs, &c.



CHAP. VII.

Of the Provision in Man's Body against Evils.

Having taken a transient View of the Structure, and Lodgment of the Parts of Human Bodies; let us next consider the admirable Provision that is made throughout Man's Body, to stave off Evils,

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CHAP. VII. Provisions against Evils. 307 and to discharge (a) them when befallen. For the Prevention of Evils, we may take the Instances already given, of the Situation of those faithful Sentinels, the Eye, the Ear, and Tongue, in the fuperiour Part of the Body, the better to descry Dangers at a Distance, and to call out presently for Help. And how well fituated is the Hand to be a fure and ready Guard to the Body, as well as the faithful Performer of most of its Services? The Brain, the Nerves, the Arteries, the Heart (b), the Lungs; and in a Word, all the principal Parts, how well are they barricaded, either with strong Bones, or deep Lodgments in the Flesh, or some fuch the wifest and fittest Method, most agreeable to the Office and Action of the Part? Besides which, for greater Precaution, and a farther Security, what an incomparable Provision hath the Infinite Contriver of Man's Body made for the Loss of, or any Defect in, some of the Parts we can least spare, by doubling them? By giving us two Eyes, two Ears, two Hands, two Kidneys, two Lobes of the Lungs, Pairs

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⁽a) One of Nature's most constant Methods here, is by the Glands, and the Secretions made by them; the Particulars of which being too long for these Notes, I shall refer to the modern Anatomists, who have written on these Subjects; and indeed, who are the only Men that have done it tolerably: Particularly, our learned Doctors Cockburn, Keil, Morland, and others at Home and Abroad: An Abridgment of whose Opinions and Observations, for the Reader's Ease, may be met with in Dr. Harris's Lex. Tech. Vol. 2. under the Words Glands, and Animal Secretion.

⁽b) In Man, and most other Animals, the Heart hath the Guard of Bones, but in the Lamprey, which hath no Bones, no not so much as a Back-bone,) the Heart is very strangely secured, and lies immur'd, or capsulated in a Cartilage, or grissy Substance, which includes the Heart, and its Auricle, as the Skulled doth the Brain in other Animals, Power's Micros. Obs. 22, X 2 (c) Here

308 Provisions against Evils. BOOK V.

Pairs of the Nerves, and many Ramifications of the Arteries and Veins in the fleshy Parts, that there may not be a Defect of Nourishment of the Parts, in Cases of Amputation, or Wounds, or Ruptures

of any of the Vessels.

And as Man's Body is admirably contriv'd, and made to prevent Evils; so no less Art and Caution hath been used to get rid of them, when they do happen. When by any Misfortune, Wounds or Hurts do befal; or, when by our own wicked Fooleries and Vices, we pull down Diseases and Mischies upon our selves, what Emunctories (c), what admirable Passages (d), are dispers'd throughout the Body; what incomparable Methods doth

(c) Here [from the Pustules he observ'd in Monomotapa,] were Grounds to admire the Contrivance of our Blood, which on some Occasions, so soon as any Thing destructive to the Constitution of it, comes into it, immediately by an intestine Commotion, endeavoureth to thrust it forth, and is not only freed from the new Guest; but sometimes what likewise may have sain lurking therein—for a great while. And from hence it comes to pass, That most Part of Medicines, when duly administred, are not only sent out of the Body themselves; but likewise great Quantities of morbisick Matter: As in Salivation, &c. Dr. Sloane's Voy. to Famaica, p. 25.

(d) Valsalva discover'd some Passages into the Region of the Ear-drum, of mighty Use, (among others,) to make Discharges of Bruises, Imposthumes, or any prulent, or morbistick Matter from the Brain, and Parts of the Head. Of which he gives two Examples: One, a Person, who from Blow on his Head, had dismal Pains therein, grew Speechless, and lay under an absolute Suppression and Decay of his Strength; but sound certain Relief, whenever he had a Flux of Blood, or purulent Matter out of his Ear; which after his Death Valsalva discover'd, was through those Passages.

The other was an Apoplettical Case, wherein he found a large Quantity of extravasated Blood, making Way from the Ventricles of the Brain, through those same Passages. Valsal.

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CHAP. VII. Provisions against Evils. 309

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(e) Hippocrates Lib, de Alimentis, takes Notice of the Sagacity of Nature, in finding out Methods and Passages for the discharging Things offensive to the Body, of which the late learned and ingenious Bishop of Clogber, in Ireland, (Boyle,) gave this remarkable Instance, to my very curious and ingenious Neighbour and Friend, D'Acre Barret, Esq; viz. That in the Plague Year, a Gentleman at the University, had a large Plague Sore gathered under his Arm, which, when they expected it would have broken, discharged it self by a more than ordinary large and sætid Stool; the Sore having no other Vent for it, and immediately becoming sound and well thereon.

Like to which, is the Story of Fos. Lazonius, of a Soldier of thirty-five Years of Age, who had a Swelling in his Right Hip, accompany'd with great Pain, &c. By the Useof emollient Medicines, having ripened the Sore, the Surgeon intended the next Day to have opened it; but about Midnight, the Patient having great Provocations to Stool, disburthen'd himself three Times; immediately upon which, both the Tumour and Pain ceased, and thereby disappointed the Surgeon's Intentions. Ephem. Germ. Anno 1690. Obf. 49. More fuch Instances we find of Mr. Tonges, in Philosoph. Trans. No. 323. But indeed there are so many Examples of this Nature in our Philosoph. Trans. in the Ephem. German, Tho. Bartholine, Rhodius, Sennertus, Hildanus, &c. that it would be Endless to recount Some have swallow'd Knives, Bodkins, Needles and Pins, Bullets, Pebbles, and twenty other fuch Things as could not find a Passage the ordinary Way, but have met with an Exit through the Bladder, or some other Way of Nature's own providing. But paffing over many Particulars, I shall only give one Instance more, because it may be a good Caution to some Persons, that these Papers may probably fall into the Hands of; and that is, the Danger of swallowing Plumb-stones, Prune-stones, &c. Sir Francis Butler's Lady had many Prune-stones that made Way through an Abscess near her Navel. Philosoph. Trans. No. 265, where are other such like Examples. More also may be found in No. 282, 304, 80c. And at this Day, a young Man, living not far off me, laboureth under very troublesome and dangerous Symptoms, from the Stones of Sloes and Bullace, which he swallow'd eight or ten Years ago. X 3 (f) Grew's

Provisions against Evils. Book V. to correct the morbifick Matter; and in a Word, to fet all Things right again? But here we had best take the Advice of a learned Physician in the Case: "The Body, (faith he,) is so contrived, as to be " well enough fecured against the Mutations in the "Air, and the leffer Errors we daily run upon; did we not in the Excesses of Eating, Drinking, "Thinking, Loving, Hating, or some other Folly, " let in the Enemy, or lay violent Hands upon our " felves. Nor is the Body fitted only to prevent; " but also to cure, or mitigate Diseases, when by " these Follies brought upon us. In most Wounds, " if kept clean, and from the Air, ---- the Flesh " will glew together, with its own native Balm. " Broken Bones are cemented with the Callus, " when themselves help to make". And so he goes on with ample Instances in this Matter, too many to be here specify'd (f). Among which he instanceth in the Distempers of our Bodies, shewing, That even many of them are highly ferviceable to the Discharge of malignant Humours, and preventing greater Evils.

And no less Kind than Admirable is this Contrivance of Man's Body, that even its Distempers should many Times be its Cure (g); that when the

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(f) Grew's Cofmel. Sett. 28, 29.

And as Diseases minister sometimes to Health; so to other good Uses in the Body, such as quickning the Senses: Of which take these Instances relating to the Hearing and Sight.

A very

⁽g) Nor are Diseases themselves useless: For the Blood in a Fever, if well-govern'd, like Wine upon the Fret, dischargeth it self of all heterogeneous Mixtures; and Nature, the Disease, and Remedies, clean all the Rooms of the House; whereby that which threatens Death, tends, in Conclusion, to the prolonging of Life. Grew, ubi supr. sect. 52.

CHAP. VIII. Confent of the Parts.

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Enemy lies lurking within to destroy us, there should be such a Reluctancy, and all Nature excited with its utmost Vigour to expel him thence. To which Purpose, even Pain it self is of great and excellent Ufe, not only in giving us Notice of the Presence of the Enemy, but by exciting us to use our utmost Diligence and Skill to root out so troublesome and destructive a Companion.

A very ingenious Physician falling into an odd Kind of Fever, had his Sense of Hearing thereby made so very nice and tender, that he very plainly heard soft Whifpers, that were made at a considerable Distance off, and which were not in the least perceiv'd by the By-standers, nor would have been by him before his Sickness.

A Gentleman of eminent Parts and Note, during a Distemper be had in his Eyes, had his Organs of Sight brought to be so tender, that both his Friends, and himself have assur'd me, That when he wak'd in the Night, he could for a while plainly see and distinguish Colours, as well as other Objects, discernable by the Eye, as was more than once try'd. Boyl. deter. nat. of Effluv. ch. 4.

Daniel Fraser -- continu'd Deaf and Dumb from his Birth, till the 17th Year of his Age ___ After his Recovery from a Fever, he perceiv'd a Motion in his Brain, which was very uneasy to him; and afterwards he began to hear, and in Process of Time, to understand Speech, Vid. Philof. Tranf. No. 312.

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CHAP VIII.

Of the Confent between the Parts of Man's Body.

IT is an admirable Provision the merciful Creator hath made for the Good of Man's Body, by the Confent and Harmony between the Parts thereof: Of which let us take St. Paul's Description, in 1 Cor. xii. 8. But now hath God fet the Members, every one of them in the Body, as it hath pleased him. And ver. 21. The Eye cannot fay

312 Consent of the Parts. Book V.

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say unto the Hand, I have no need of thee: Nor again, the Head to the Feet, I have no need of you. But such is the Consent of all the Parts, or as the Apostle wordeth it, God hath so tempered the Body together, that the Members should have the same Care one for another, ver. 25. So that whether one Member suffer, all the Members suffer with it; or one Member be honoured (or affected with any good,) all the Members rejoyce,

[and sympathize] with it, ver. 26.

This mutual Accord, Consent and Sympathy of the Members, there is no Reason to doubt (a), is made by the Commerce of the Nerves (b), and their artificial Politions, and curious Ramifications throughout the whole Body, which is admirable and incomparable, and might deserve a Place in this Survey, as greatly, and manifestly setting forth the Wildom and Benignity of the Great Creator; but that to give a Description thereof from the Origin of the Nerves, in the Brain, the Cerebellum and Spine, and so through every Part of the Body, would be redious, and intrench too much upon the Anatomist's Province: And therefore one Instance shall suffice for a Sample of the Whole; and that shall be, (what was promis'd before

(a) See Book 4. Chap. 8.

⁽b) Tria proposita ipst Natura in Nervorum distributione sucrunt.

1. Ut sensories instrumentis Sensum impertiret.

2. Ut motories Motum.

3. Ut omnibus alies [partibus] daret ut qua si dolorem adservent, dignoscerent. And afterwards, Si quis en dissectionibus spectavit, consideravitque justine, an secus Natura Nervos non eddem mensura omnibus partibus distribuerit, sed alies quidem liberalius, alies verò parcius, eadem cum Hippocrate, velit nolit, de Natura omnino pronunciabit, quod ca scilicet sagax, justa, artisciesa, animaliumque provida est. Galen. de Us. Part. 1. 5. c. 9.

fore (c), the great Sympathy occasion'd by the Fifth Pair of Nerves; which I chuse to instance in, rather than the Par vagum, or any other of the Nerves, because although we may have less Variety of noble Contrivance and Art, than in that Pair; yet we shall find enough for our Purpose, and which may be dispatch'd in fewer Words. Now this Fifth Conjugation of Nerves, is branched to the Ball, the Mulcles, and Glands of the Eye; to the Ear; to the Jaws, the Gums, and Teeth ; to the Muscles of the Lips (d); to the Tonsils, the Palate, the Tongue, and the Parts of the Mouth; to the Pracordia also, in some Measure, by inosculating with one of its Nerves; and lastly, to the Muscles of the Face, particularly the Cheeks, whose fanguiferous Vessels it twists about.

From hence it comes to pass, that there is a great Consent and Sympathy (e) between these Parts; fo that a gustable Thing seen or smelt, excites the Appetite, and affects the Glands and Parts of the Mouth; that a Thing feen or heard, that is fhameful, affects the Cheeks with modest Blushes; but on the contrary, if it pleases and tickles the Fancy, that it affects the Pracordia.

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⁽c) Book 4. Chap. 5.

⁽d) Dr. Willis gives the Reason, cur mutua Amasiorum oscula labiis impressa, tum pracordia, tam genitalia afficiendo, amorem ac libidinem tam facile irritant, to be from the Consent of those Parts, by the Branches of this Fifth Pair. Nerv. Descr. c. 22.

And Dr. Sachs judges it to be from the Consent of the Labia Oris cum Labiis Uteri, that in April 1669, a certain breeding Lady, being affrighted with feeing one that had fcabby Lips, which they told her were occasion'd by a pestilential Fever, had such like Pustules brake out in the Labia Uteri. Ephem, Germ. T. 1. Obf. 20.

Consent of the Parts. Book V. and Muscles of the Mouth and Face with Laughter : but a Thing causing Sadness and Melancholy, doth accordingly exert it self upon the Pracordia. and demonstrate it felt by causing the Glands of the Eyes to emit Tears (f), and the Muscles of the Face to put on the forrowful Afpect of Crying, Hence also that torvous four Look produc'd by Anger and Hatred: And that gay and pleasing Countenance accompanying Love and Hope. And in fhort, it is by Means of this Communication of the Nerves, that whatever affects the Soul, is demonstrated, (whether we will or no,) by a consentaneous Disposition of the Pracordia within, and a fuitable Configuration of the Muscles and Parts of the Face without. And an admirable Contrivance of the Great GOD of Nature this is; That as a Face is given to Man, and as Pliny faith (g), to Man alone of all Creatures; fo it should be, (as he observes;) the Index of Sorrow and Chearfulness, of Compassion and Severity. In its ascending Part is the Brow, and therein a Part of the Mind too. Therewith we deny, therewith we confent. With this it is we show our Pride, which bath its Source in another Place; but bere its Seat: In the Heart it bath its Birth: but here it abides and dwells; and that because

(v) Confult Willis ubi suprà.

Tempus moramque dahimus, arbitrio tuo Implere lacrymis: Fletus arumnas levat. it

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⁽f) Tears serve not only to moisten the Eye, to clean and brighten the Cornea, and to express our Grief; but also to alleviate it, according to that of Ulyses to Andromache, in Seneca's Troas, ver. 762.

⁽g) Plin. Nat. Hift. 1. 11. c. 37.

CHAP. IX. The Variety of Men's, &c. 315 it could find no other Part throughout the Body higher, or more craggy (b), where it might reside alone.

Thus I have dispatch'd what I shall remark concerning the Soul and Body of Man. There are divers other Things, which well deserve a Place in this Survey; and these that I have taken Notice of, deserv'd to have been enlarg'd upon: But what hath been said, may suffice for a Taste and Sample of this admirable Piece of God's Handy-work; at least serve as a Supplement to what others have said before me. For which Reason I have endeavour'd to say as little wittingly as I could, of what they have taken Notice of, except where the Thread of my Discourse laid a Necessity upon me.

(b) Nibil altius simul abruptiusque invenit.

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CHAP. IX.

Of the Variety of Mens Faces, Voices, and Hand-Writing.

HERE I would have put an End to my Observations relating to Man; but that there are three Things so expressly declaring the Divine Management and Concurrence, that I shall just mention them, although taken Notice of more amply by others; and that is, The great Variety throughout the World of Mens Faces (a), Voices (b), and

⁽a) If the Reader hath a Mind to fee Examples of Men's Likeness, he may consult Valer. Maximus, 1. 9. c. 14. concerning the Likeness of Pompey the Great, and Vibius, and Publicius

(b), and Hand-writing. Had Man's Body been made according to any of the Atheistical Schemes, or any other Method than that of the Infinite Lord of the World, this Wise Variety would never have been: But Mens Faces would have been cast in the same, or not a very different Mould; their Organs of Speech would have sounded the same, or not so great a Variety of Notes; and the same Structure of Muscles and Nerves, would have given the Hand the same Direction in Writing. And in this Case, what Consusion, what Disturbance, what Mischiess would the World eternally have lain under? No Security could have been to our Persons; no Certainty, no Enjoyment of our Possessions (c); no Justice between Man and Man;

Publicius Libertinus; as also of Pompey the Father, who got the Name of Coquus, he being like Menogenes the Cook; with divers others.

(c) Regi Antiocho unus ex aqualibus—nomine Artemon, perquam fimilis fuisse traditur. Quem Laodice, uxor Antiochi, interfecto vivo, dissimulandi sceleris gratia, in lectulo perinde quasi Regem agrum collocavit. Admissumque universum populum, & sermone ejus

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⁽b) As the Difference of Tone makes a Difference between every Man's Voice, of the same Country, yea, Family; so a different Dialect and Pronunciation, differs Persons of divers Countries; yea, Persons of one and the same Country, speaking the same Language: Thus in Greece, there were the lonick, Dorick, Attick, and Eolick Dialects. So in Great-Britain, besides the grand Diversity of English and Scotch, the different Counties vary very much in their Pronunciation, Accent and Tone, although all one and the same Language. And the Way of the Gileadites proving the Ephraimites, Judg. xii. 6. by the Pronunciation of Shibboleth, with a Schin, or Sibboleth with a Samech, is well known. So a Lapide saith, the Flemings prove whether a Man be a Frenchman or not, by bidding him pronounce Acht en tachtenticht; which they pronounce, Att en tattentic, by Reason they can't pronounce the Aspirate b.

CHAP. IX. of Men's Faces, &c. 317

no Distinction between Good and Bad, between Friends and Foes, between Father and Child. Husband and Wife, Male or Female; but all would have been turn'd topfey-turvey, by being expos'd to the Malice of the Envious and Ill-natur'd, to the Fraud and Violence of Knaves and Robbers, to the Forgeries of the crafty Cheat, to the Lusts of the Effeminate and Debauch'd, and what not! Our Courts of Justice (d), can abundantly testify the dire Effects of mistaking Men's Faces, of counterfeiting their Hands, and forging Writings. But now, as the Infinitely Wife Creator and Ruler hath order'd the Matter, every Man's Face can distinguish him in the Light, and his Voice in the Dark; his Hand-writing can speak for him though absent, and be his Witness, and secure his Contracts in future Generations. A manifest, as well as admirable Indication of the Divine Superintendence and Management (e).

😂 vultu consimili fefellit : credideruntque homines ab Antiocho moriente Laodicen & natos ejus sibi commendari. Valer. Max. ib.

(d) Quid Trebellius Calca! quam affeveranter sese Clodium tulit! & quidem dum de bonis ejus contendit, in centumvirale judicium aded favorabilis descendit, ut vix justis & aquis sententiis consternatio populi ukum relinqueret locum. In illa tamen quaftione neque calumnia petitoris, neque violentia plebis judicantium religio cessit. Val. Max.

ib. c. 15. (e) To the foregoing Instances of Divine Management, with relation to the political State of Man, I shall add another Thing, that I confess hath always seem'd to me somewhat odd, but very providential; and that is, the Value that Mankind, at least the civiliz'd Part of them, have in all Ages put upon Gems, and the purer finer Metals, Gold and Silver; so as to think them equivalent unto, and exchange them for Things of the greatest Use for Food, Cloathing, and all other Necessaries and Conveniences of Life. Whereas those Things themselves are of very little, if any Use in Physick, Food, Building or Cloathing, otherwise than for Ornament, or to minister to Luxury; as Suetonius tells us

of Nero, who fish'd with a Net gilt with Gold, and shod his Mules with Silver; but his Wife Poppaa, shod her Horses with Gold. Vit. Ner. c. 30. Plin. N. H. L. 33. c. 11. So the fame Suetonius tells us, Jul. Cafar lay in a Bed of Gold, and rode in a Silver Chariot. But Heliogabilus rode in one of Gold, and had his Clofe-stool Pans of the same Metal. And Pliny faith, Vasa Coquinaria ex argento Calvus Orator fieri queritur, Ibid. Neither are those precious Things of greater Use to the making of Veffels, and Utenfils, (unless some little Niceries and Curiofities,) by Means of their Beauty, Imperdibility, and Ductility. Of which last, the great Mr. Boyle hath, among others, these two Instances, in his Esfay about the Sub. tility of Effuviums, Chap. 2. Silver, whose Ductility, and Tractility are very much inferiour to those of Gold, was, by my procuring, drawn out to so slender a Wire, that ____ a single Grain of it amounted to twenty seven Feet. As to Gold, he demonstrates it possible to extend an Ounce thereof, to reach to 777600 Feet, or 155 Miles and an half, yea, to an incredibly greater Length.

And as to Gems, the very Stories that are told of their prodigious Virtues, are an Argument, that they have very little. or none more than other hard Stones. That a Diamond should discover whether a Woman be true or false to her Husband's Bed; cause Love between Man and Wife; secure against Witchcraft, Plague and Poisons; that the Ruby should dispose to Cheerfulness, cause pleasant Dreams, change its Colour against a Missortune befalling, &c. that the Sapphire should grow foul, and lose its Beauty, when worn by one that is Leacherous; that the Emerald should fly to pieces, if it touch the Skin of any unchaste Person in the Act of Uncleanness: That the Chrysolite should lose its Colour, if Poyson be on the Table, and recover it again when the Poyfon is off: And, to name no more, that the Turcoife, (and the same is faid of a Gold Ring,) should strike the Hour when hung over a drinking Glass, and much more to the same Purpose: All these, and many other such fabulous Stories, I say, of Gems, are no great Arguments, that their Virtue is equivalent to their Value. Of these, and other Virtues, consult Worm in his Mufeum, 1. 1. fett. 2. c. 17, &c.

But as to Gems changing their Colour, there may be fomewhat of Truth in that, particularly in the Turcoife last mention'd. Mr. Boyle observ'd the Spots in a Turcoife, to shift their Place from one Part to another, by gentle Degrees. So did the Cloud in an Agate-handle of a Knife. A Diamond he wore on his Finger, he observ'd to be more illustrious at some Times than others: Which a curious Lady told him she had also observ'd in hers. So likewise a rich Ruby did the same. Boyle of Absol. Rest in Bodies.

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CHAP. X.

The Conclusion of the Survey of MAN.

ND now having taken a View of Man, and A finding every Part of him, every Thing relating to him contriv'd, and made in the very best Manner; his Body fitted up with the utmost Forefight, Art and Care; and this Body, (to the great Honour, Privilege, and Benefit of Man,) posses'd by a Divine Part, the Soul, a Substance made as it were on Purpose to contemplate the Works of God, and glorify the Great Creator; and fince this Soul can difcern, think, reason, and speak; What can we conclude upon the whole Matter, but that we lie under all the Obligations of Duty and Gratitude, to be thankful and obedient to, and to fet forth the Glories of our Great Creator, and Noble Benefactor? And what ungrateful Wretches are we, how much worse than the poor Irrationals, if we do not employ the utmost Power of our Tongue, and all our Members, and all the Faculties of our Souls in the Praises of God! But above all, should we, who have the Benefit of those Glorious Acts and Contrivances of the Creator, be fuch wicked, fuch base, such worse than brutal Fools, to deny the Creator (a), in some of his noblest Works?

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⁽a) It was a pious, as well as just Conclusion, the ingenious Laurence Bellini makes of his Opusculum de Motu Cordis, in these Words: De Motu Cordis isthac. Que equidem omnia, si à rudi intelligentià Hominis tantum consilii, tantum ratiocinii, tantum peritia mille rerum, tantum scientiarum exigunt, ad koc, ut inveniantur, sen

BOOK V.

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Should we so abuse our Reason, yea, our very Senses; should we be so besotted by the Devil, and blinded by our Lusts, as to attribute one of the best contriv'd Pieces of Workmanship to blind Chance, or unguided Matter and Motion, or any other such sottish, wretched, atheistical Stuff; which we never saw, nor ever heard made any one Being (b) in any Age since the Creation? No, No! But like wise and unprejudic'd Men, let us with David say, Psalm exxxix. 14. (with which I conclude,) I will praise thee, for I am

ad boc, ut percipiantur postquam facta funt ; illum, cujus opera, fabre. facta funt bac fingula, tam vani erimus atque inanes, ut existimemus esse consilir impotem, rationis expertem, imperitum, aut ignarum om. nium rerum? Quantum ad me attinet nolim effe Rationis compos, fi tantum insudandum mibi effet ad consequendam intelligentiam earum rerum, quas fabrefaceret nescio qua Vis, qua nibil intelligeret eorum que fabrefaceret; mihi etenim viderer effe vile quiddam, atque ridiculum qui vellem totam atatem meam, sanitatem. & quicquid bumanum ef deterere, nibil curare quicquid est jucunditatum, quicquid latitiarum, quicquid commoderum; non divitias, non dignitates: non pænas etiam, & vitam ipsam, ut gloriari possem postremo invenisse unum, aut alurum. & fortasse me invenisse quidem ex iis innumeris, que produxisset, nescio quis ille, qui sine labore, sine curà, nibil cogrtans, nibil cognosiens, non unam aut alteram rem, neque dubie, sed certo produxisset imumeras innumerabilitates rerum in hoc tam immenso spatio corporum, ex quibu totus Mundus compingitur. Ab Deum immortalem! Video prasens mimen tuum in hisce tam prodigiosis Generationis initiis. & in altissimi eorum contemplatione defixus, nescio quo cestro admirationis conciter, & quasi divine furens cobiberi me minime possum quin exclamem.

Magnus Dominus! Magnus Fabricator Hominum Deus! Magnus atque Admirabilis! Conditor rerum Deus qu'am Magnus es! Bellia

de Mot. Cord. fin.

(b) Hoc [i. e. mundum effici ornatissimum, & pulcherismum est concursione fortuita] qui existimat sieri potuisse, non intelligo cur non idem putet, si innumerabiles unius, & viginti sorma literarum, vel aurea, vel qualeslibet, aliquo conjiciantur, posse ex in interam excussis annales Ennii ut deinceps legi possint, essici, &c. — Qual si Mundum efficere potest concursus Atomorum, cur porticum, cur templum, cur domum, cur urbem non potest? Qua sunt minus operosa, & multo quidem faciliora. Cic. de Nat. Deor. 1. 2. c. 37.

CHAP. I. The Posture of Quadrupeds. 32t fearfully and wonderfully made; marvellous are thy Works, and that my Soul knoweth right well.

Having thus made what (confidering the Copiousness and Excellence of the Subject,) may be called a very brief Survey of Man, and seen such admirable Marks of the Divine Design and Art; let us next take a transient view of the other inferiour Creatures; and begin with Quadrupeds:

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BOOK VI.

ASURVEY of QUADRUPEDS.

CHAP. I.

Of their Prone POSTURE.

IN taking a View of this Part of the Animal World, so far as the Structure of their Bodies is conformable to that of Man, I shall pass them by, and only take Notice of some Peculiarities in them, which are plain Indications of Design, and the Divine Super-intendence and Management. And, 1. The most visible apparent Variation is the Prone Posture of their Body: Concerning which, I shall take Notice only of two Things, the Parts ministring thereto, and the Use and Benefit thereof.

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322 The Posture of Quadrupeds. BOOK VI.

I. As for the Parts, it is observable, That in all these Creatures, the Legs are made exactly conformable to this Posture, as those in Man are to his erect Posture: And what is farther observable also, is, That the Legs and Feet are always admirably suited to the Motion and Exercises of each Animal: In some they are made for Strength only, to support a vast, unwieldy Body (a); in others they are made for Agility and Swiftness (b), in some they are made for only Walking and Running, in others for that, and Swimming too (c); in others for Walking and Digging (d); and in others for Walking and Digging (d); and in others for

(b) Deer, Hares, and other Creatures, remarkable for Swiftness, have their Legs accordingly slender, but withat

strong, and every Way adapted to their Swiftness.

(c) Thus the Feet of the Otter are made, the Toes being all conjoined with Membranes, as the Feet of Geefe and Ducks are. And in Swimming, it is observable, That when the Foot goes forward in the Water, the Toes are close; but when backward, they are spread out, whereby they more forcibly strike the Water, and drive themselves forward. The same may be observed also in Ducks and Geese,

Of the Castor or Beaver, the French Academists say, The Structure of the Feet was very extraordinary, and sufficiently demonstrated; that Nature hath designed this Animal to live in the Water, as well as upon Land. For although it had sour Feet, like Terrestrial Animals, yet the hindmost seemed more proper to swim than walk with the Five Toes of which they were composed, being joined together like those of a Goose by a Membrane, which sorves this Animal to swim with. But the fore Ones were made otherwise; for there was no Membrane, which held those Toes joined together: And this was requisite for the Conveniency of this Animal, which uset them as Hands like a Squirrel, when he eats. Memoirs for a Natural History of Animals, pag. 84.

(d) The Mole's Feet are a remarkable Instance.

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⁽a) The Elephant being a Creature of prodigious Weight, the largest of all Animals, Pliny faith, hath its Legs accordingly made of an immense Strength, like Pillars, rather than Legs.

CHAP. I. The Posture of Quadrupeds. 323

Walking and Flying (e): In some they are made more laks and weak, for the plainer Lands; in others rigid, stiff, and less flexible (f), for traversing the Ice, and dangerous Precipices of the high Mountains (g); in some they are shod with tough and hard Hoofs, some whole, some cleft; in others with only a callous Skin. In which latter, it is observable that the Feet are composed of Toes, some short for bare-going; some long to supply the Place of a Hand (b); some armed with long and strong Talons to catch, hold, and tear the Prey; some send only with short Nails, to consirm the Steps in Running and Walking.

II. As the Posture of Man's Body is the sittest for a Rational Animal, so is the Prone Posture of Quadrupeds the most useful and beneficial to them=

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(e) The Wings of the Bat are a prodigious Deviation from Nature's ordinary Way. So it is in the Virginian Squirrel, whose skin is extended between the Fore-legs and its Body.

(f) Of the Legs of the Elk, the French Academists say, Altough some Authors report, That there are Elks in Musicovia, whose Legs are jointless; there is great Pr. bability, that this Opinion is founddon what is reported of those Elks of Musicovia, as well as of Caar's Alce, and Pliny's Machlis, that they have Legs so stiff and inlexible, that they do run on see without slipping; which is a Way that reported that they have to save themselves from the Wolves, Sec. Ibid. 108.

(e) The common tame Goat, (whose Habitation is generally m Mountains and Rocks, and who delighteth to walk on the Tops of Pales, Houses, &c. and to take great and seemingly angerous Leaps) I have observed, hath the Joints of the Legs ery stiff and strong, the Hoof hollow underneath, and its Edges sharp. The like, I doubt not, is to be found in the Wild Goat, considering what Dr. Scheuchzer hath said of its limbing the most dangerous Craggs of the Alps, and the Maner of their hunting it. Vid. Iter. Alpin. 3. p. g.

(b) Thus in Apes and Monkeys, in the Beaver before, and di-

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224 The Posture of Quadrupeds. Book VI.

selves, as also most serviceable to Man. For they are hereby better made for their gathering their Food, to pursue their Prey, to leap, to climb, to swim, to guard themselves against their Enemies; and in a Word, to do whatever may be of principal Use to themselves; as also, they are hereby rendered more useful and serviceable to Man, for carrying his Burdens, for Tilling his Ground; yea, even for his Sports and Diversions.

And now I might here add a Survey of the excellent Contrivances of the Parts ministring to this Posture of the four-footed Animals, the admirable Structure of the Bones (i), the Joints and Muscles, their various Sizes and Strength; their commodious Lodgment and Situation, the nice Æquipoise of the Body, with a great deal more to the same Purpose. But I should be tedious to insist minutely upon such Particulars; and besides, I have given a Touch upon these Kinds of Things, when I spake of Man.

Passing by therefore many Things of this Kind, that might deserve Remark, I shall only consider some of the Parts of the Quadrupeds, differing from what is found in Man (k), and which are manifelt Works of Design.

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⁽i) It is a fingular Provision Nature hath made for the Strength of the Lion, if that be true, which Galen saith is reported of its Bones being not hollow (as in other Animals) but solid: Which Report he thus far confirms, that most at the Bones are so; and that those in the Legs, and someother Parts, have only a small and obscure Cavity in them. We Galen, de Us. Part. 1. 11. c. 18.

⁽k) These Sorts of Differences in the Mechanism of Animals, up the Score of the Position of their Bodies, occur so often, that it would no mean Service to Anatomy—if any one would give us a History these Variations of the Parts of Animals, which spring from the different I oftures of their Bodies. Drake Anat. V. 1. B. 1. c. 17.

Of the Heads of Quadrupeds.

IT is remarkable, that in Man, the Head is of one fingular Form; in the four-footed Race, as various as their Species. In some, square and large, fuitable to their flow Motion, Food, and Abode; in others less, slender, and sharp, agreeable to their fwifter Motion, or to make their Way to their Food (a), or Habitation under Ground (b). But paffing by a great many Observations that might be made of this Kind, I shall stop a little at the Brain, as the most considerable Part of this Part of the Body, being the great Instrument of Life and Motion in Quadrupeds, as it is in Man of that, as also in all Probability the chief Seat of his Immortal Soul. And accordingly it is a remarkable Difference, that in Man the Brain is large, affording Substance and Room for so noble a Guest; whereas in Quadrupeds. it is but small. And another Thing, no less remarkable, is the Situation of the Cerebrum and Cerebellum.

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⁽a) Thus Swine, for Instance, who dig in the Earth for Roots, and other Food, have their Neck, and all Parts of their Head very well adapted to that Service. Their Neck short, brawny, and strong; their Eyes set pretty high out of the Way; their Snout long; their Nose callous and strong; and their Sense of Smelling very accurate, to hunt out and distinguish their Food in Mud, under Ground, and other the like Places where it lies concealed.

⁽b) What hath been said of Swine is no less, rather more remarkable in the Mole, whose Neck, Nose, Eyes and Ears, are all fitted, in the nicest Manner, to its subterraneous Way of Life.

326 The Heads of Quadrupeds. BOOK VI. bellum, or the greater or leffer Brain, which I shall give in the Words of one of the most exact Anatomists we have of that Part (c): "Since, faith he, "God hath given to Man a lofty Countenance, to se behold the Heavens, and hath also seated an imso mortal Soul in the Brain, capable of the Contemplation of Heavenly Things; therefore, as his Face is erect, fo the Brain is fet in an higher Flace, namely, above the Cerebellum, and all " the Senfories. But in Brutes, whose Face is prone towards the Earth, and whose Brain is caco pable of Speculation, the Cerebellum, (whole Est Bufiness it is to minister to the Actions and Func-"tions of the Pracordia, the principal Office in "those Creatures) in them is situated in the higher " Place, and the Cerebrum lower. Also some of the Organs of Sense, as the Ears and Eyes, are " placed, if not above the Cerebrum, yet at least " equal thereto.

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Another Convenience in this Position of the Cerebrum and Cerebellum, the last ingenious Anatomist (d) tells us is this, "In the Head of Man, saith he, the Base of the Brain and Cerebell, yea, of the whole Skull, is set parallel to the Horizon; by which Means there is the less Danger of the two Brains joggling, or slipping out of their Place. But in Quadrupeds, whose Head hangs down, the Base of the Skull makes a right Angle with the Horizon, by which Means the

(c) Willis Cereb. Anat. cap. 6. Cumque huic Deus os sublime de-

Brain is undermost, and the Cerebell uppermost;

(d) Id, paulo post. In capite humano Cerebri & Cerebelli, &c.

CHAP. II. The Heads of Quadrupeds. 327

" fo that one would be apt to imagine the Cere-" bell should not be steady, but joggle out of its " Place." To remedy which Inconvenience, he tells us, "And lest the frequent Concussions of " the Cerebell should cause a Fainting, or disorder-" ly Motion of the Spirits about the Pracordia, " therefore, by the Artifice of Nature, sufficient Pro-" vision is made in all, by the dura Meninx close-" ly encompassing the Cerebellum; besides which, " it is (in some) guarded with a strong bony Fence; " and in others, as the Hare, the Concy, and " fuch leffer Quadrupeds, a part of the Cerebell is " on each Side fenced with the Os Petrofum:

"So that by this double Stay, its whole Mass is

" firmly contained within the Skull.

Besides these Peculiarities, I might take notice of divers other Things no less remarkable, as the Nittitating Membrane of the Eye (e), the different Passages of the Carotid Arteries (f) through the Skull,

(e) See Book IV. Chap. 2. Note (kk).

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⁽f) Arteria Carotis aliquanto posterius in homine quam in alio quovis animali, Calvariam ingreditur, scil, juxta illud foramen, per quod sinus lateralis in Venam jugularem desiturus cravio elabitur; nam in cateris hac arteria sub extremitate, seu processu acuto ossis petrosi, inter cranium emergit: verûm in capite humano, eadem, ambage longiori circumducta (ut sanguinis torrens, priusquam ad cerebri oram appellit fracto impetu, lenius & placidius fluat) propo specum ab ingressu sinus lateralis factum, Calvaria basin attingit; — 👺 in majorem cautelam, tunica insuper ascititia crassiore investitur. And so he goes on to shew the Conveniency of this Guard the Artery hath, and its Paffage to the Brain, and then faith, Si bujusmodi conformationis ratio inquiritur, facile occurrit, in capite humano, ubi generosi affectus & magni animorum impetus ac ardores excitantur, sanguinis in Cerebri oras appulsum debere esse liberum & expeditum, &. Atque hoc quident respectu differt Homo à plerisque Brutis, quibus, Arteria in mille surculos divisa, ne sanguinem pleniore alveo, aut citariore, quam par oft, cursu, ad cerebrum evehat, Plexus Retiformes con-Stituit.

328 The Necks of Quadrupeds. BOOK VI. Skull, their Branching into the Rete Mirabile (g), the different Magnitude of the Nates, and some other Parts of the Brain in Beasts, quite different from what it is in Man: But the Touches already given, may be Inflances sufficient to prevent my being tedious in inlarging upon these admirable Works of God.

fituit, quibus nempe efficitur, ut sanguis tardo admodum, lenique & equabili fere stillicidio, in cerebrum illabatur. And then he goes on to give a farther Account of this Artery, and the Rete Mira-

bile in divers Creatures, Willis, ibid. c. 8.

(g) Galen thinks the Rete Mirabile is for concocting and elaborating the Animal Spirits, as the Epididymides, [the Convolutions argoeides [are for elaborating the Seed, This Rete is much more conspicuous De Uf. Part. 1. 9. c. 4. in Beasts than Man; and, as Dr. Willis well judges, serves 1. To bridle the too rapid Incursions of the Blood into the Brain of those Creatures, whose Heads hang down much, 2. To separate some of the superfluous serous Parts of the Blood, and fend them to the Salival Glands, before the Blood enters the Brain of those Animals, whose Blood is naturally of a watery Constitution. 3. To obviate any Obstructions that may happen in the Arteries, by giving a free Passage through other Veffels, when some are stopped.

In Quadrupeds, as the Carotid Arteries are branched into the Rete Mirabile, for the bridling the too rapid Current of Blood into the Brain; so the Vertebral Arteries, are, near their Entrance into the Skull, bent into an acuter Angle than in Man, which is a wife Provision for the same Purpose.

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CHAP. III, Of the Necks of Quadrupeds.

ROM the Head pass we to the Neck, no principal Part of the Body, but yet a good Instance of the Creator's Wisdom and Design, inalmuch as in Man it is short, agreeable to the Erection

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E peci CHAP. III. The Necks of Quadrupeds. 329 tion of his Body; but in the Four-footed Tribe it is long, answerable to the Length of the Legs (a), and in some of these long, and less strong, serving to carry the Mouth to the Ground; in others shorter, brawny and strong, serving to dig, and heave up great Burdens (b).

But that which deserves especial Remark, is that peculiar Provision made in the Necks of all, or most granivorous Quadrupeds, for the perpetual holding down their Head in gathering their Food, by that strong, tendinous and insensible Aponeurosis, or Ligament (c) braced from the Head to the middle of the Back. By which means the Head, al-

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Aliorum ea est humilitas ut cibum terrestrem rostris facile contingant. Que autem altiora sunt, ut Anseres, ut Cygni, ut Grues, ut Cameli, adjuvantur proceritate collorum. Manus etiam data Elephantis, qui propter magnitudinem corporis difficiles aditus habebant ad pastum. Cic. de N. D. l. 2. c. 47.

Quod iis animalibus qua pedes habent fissos in digitos, Collum brevius sit factum, quam ut per ipsum Cibum ori admovere queant: iis verd qua ungulas habent solidas, aut bistdas, lengius, ut prona atque inclinantia pasci queant. Qui id etiam opus non sit Artisticis utilitatis memoris? Ad hac quod Grues ac Ciconia, cum crura haberent longiora, ob eam causam Rostrum etiam magnum, & Collum longius habuerint. Pisces autem neque Collum penitus habuere, utpote qui nequa Crura habent. Quo pacto non id etiam est admirandum? Galende Us. part. 1. 11. c. 8.

⁽a) It is very remarkable, that in all the Species of Quadrupeds, this Equality holds, except only the Elephane; and that there should be a sufficient special Provision made for that Creature, by its Proboscis or Trunk. A Member so admirably contrived, so curiously wrought, and with so great Agility and Readiness, applied by that unweildy Creature to all its several Occasions, that I take it to be a manifest Instance of the Creator's Workmanship. See its Anatomy in Dr. A. Moulen's Anat. of the Elephant, p. 33. As also in Mn. Blair's Account in Phil. Trans. No. 326.

⁽b) As in Moles and Swine, in Ch. 2, Note (a).

⁽c) Called the Whiteleather, Packwax, Taxwax, and Fixfax.
(d) The

though heavy, may be long held down without any Labour, Pain, or Uneafiness to the Muscles of the Neck, that would otherwise be wearied by being so long put upon the Stretch.

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CHAP. IV.

blod Of the Stomachs of Quadrupeds.

FROM the Neck, let us descend to the Stomach, a Part as of absolute Necessity to the Being and Well-being of Animals, so is in the several Species of Quadrupeds, sized, contrived, and made with the utmost Variety and Art. (a) What Artist, what Being, but the Infinite Conservator of the World, could so well adapt every Food to all the several Kinds of those grand Devourers of it! Who could so well sute their Stomachs to the Reception and Digestion thereof; one kind of Stomach to the Carnivorous, another to the Herbaceous Animals; one sitted to digest by a bare Massication; and a whole Set of Stomachs in others, to digest with the Help of Rumination! Which

⁽a) The peculiar Contrivance and Make of the Dremedary or Camel's Stomach, is very remarkable, which I will give from the Parisian Anatomists: At the top of the Second [of the Ventricles] there were several square Holes, which were the Orifia of about 30 Cavities, made like Sacks placed between the two Membranes, which do compose the Substance of this Ventricle. The View of these Sacks made us to think that they might well be the Reservatoria, where Pliny saith, that Camels do a long Time keep the Water, while they drink in great Abundance—to supply the Wants thereof in the dry Desarts, &c. Vid. Memoirs, &c. Anat. of Dromedary, p. 39. See also Peyer, Merycol. 1, 2, c, 3.

CHAP. V. The Hearts of Quadrupeds. 331

last Act, together with the Apparatus for that Service, is so peculiar, and withal so curious an Artifice of Nature, that it might justly deserve a more particular Enquiry; but having formerly mentioned it (b), and lest I should be too tedious, I shall pass it by.

(b) Botk IV. Chap. 11. .

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CHAP. V.

Of the Hearts of Quadrupeds.

In this Part there is a notable Difference found between the Heart of Man and that of Beafts; concerning the latter, of which I might take Notice of the remarkable Confirmation of the Hearts of Amphibious Quadrupeds, and their Difference from those of Land-Animals, some having but one Ventricle (a), some three (b), and some but two like Land-Animals but then the Foramen Ovale therewith (c). All which may be justly esteemed

(a) Frogs are generally thought to have but one Ventricle n their Hearts.

(c) The Sea-Calf is faid by the French Academists, to have his Provision, and their Account of it is this: Its Heart was ound and stat, Its Ventricles appeared very large, and its Auricles

Small.

⁽b) The Tortoise hath three Ventricles, as the Parisian Acaemists in their Memoirs affirm. Besides these two Ventricles [beore spoken of] which were in the hinder Part of the Heart, which
aceth the Spine; there was, say they, a third in the Fore-part, inlining a little towards the Right-side, &c. Memoirs, &c. p. 259.
But Mr. Bussiere charges this as a Mistake in those ingenious
Gentlemen, and afferts there is but one Ventricle in the Torisse's Heart. See his Description of the Heart of the LandTortoise, in Philos. Transatt, No. 328.

as wonderful, as they are excellent Provisions for the Manner of those Animals living. But I shall content my self with bare Hints of these Things, and speak only of two Peculiars more, and that but briefly

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but briefly. One is the Situation of the Heart, which in Beafts is near the middle of the whole Body; in Man, nearer the Head (d). The Reasons of which I shall give from one of the most curious Anatomists of that Part (e). " Seeing, faith he, the Trajecce tion and Distribution of the Blood depends whol-" ly on the Systole of the Heart, and that its Liquor is not driven of its own Nature so readily ec into the upper Parts as into Vessels even with it ec or downwards into those under it : If the Situace tion of the Heart had been farther from the Head, it must needs either have been made stronger to so cast out its Liquor with greater Force; or elle "the Head would want its due Proportion of " Blood. But in Animals that have a longer Neck, " and which is extended towards their Food as it e were, the Heart is seated as far from the other Parts; and they find no Inconvenience from it, " because they feed with their Head for the most

" part hanging down; and so the Blood, as it hath

(e) Dr. Lower, de Corde, c. I.

Inal. Underneath the great Aperture, through which the Trunki the Vena Cava conveyed the Blood into the right Ventricle of the Head there was another, which penetrated into the Arteria Venosa, and from thence into the left Ventricle, and afterwards into the Aorta. The Hole, called the Foramen Ovale in the Foetus, makes the Anastornosis, by the Means of which, the Blood grees from the Cava into the Aorta, without passing through the Lungs. French Anatomist, p. 124.

⁽d) The TE Kapsiar mgl To peror man is 'Allgory, &c. Arift. Hift. An. l. 2. c. 17.

CHAP. V. The Hearts of Quadrupeds. 333

" farther to go to their Head than in others, so it

" goes a plainer and often a steep Way (f).

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The other peculiar Matter is, the fastning (I formerly mentioned) which the Cone of the Pericordium hath in Man to the Diaphragm (g), whereas in all Quadrupeds it is loose. By which Means the Motion of the Midriff, in that necessary Act of Respiration, is assisted both in the upright Posture of Man, as also in the prone Posture of Quadrupeds (b), which would be hindred, or rendred more Difficult, if the Case was otherwise: "Which must needs be the Effect of Wisdom and Design," and that Man was intended by Nature to walk erect, and not upon all-four, as Quadrupeds "do":

(g) Diaphragmatis circulo nerveo sirmiter adharet [Pericordium] quod Homini singulare; nam ab eo in Canibus & Simiis distat, item.

in aliis animalibus omnibus. Bartholin, Anat. l. 2. c. 5.

⁽f) I might have mentioned another wise Provision from the same Author, which take in his own Words: In vitulis & Equis, imò plerique aliis animalibus majoribus, non solas propagines à Nervo sexti paris ut in Homine, sedetiam plurimas à Nervo intercostali, ubi restà cor transit, cor accedere, imò in parenchyma ejus dimitti: & hoc ideo à Natura quasi subsidium Brutis comparatum, ne capita qua terram prona spectant, non satis facile aut copiose Spiritus Animales impertirent. Blassi Anat. Animal, Par. 1. c. 4. ex Lowero, de Corde.

⁽h) Finalem causam quod attinet, ——cùm ere us sit Hominis insessus atque figura, eoque faciliùs abdominis viscera suo pondere descendant, minore Diaphragmatis nixu atque Systole ad Inspirationem opus
est: perrò, cùm in Exspiratione pariter necessarium sit Diaphragma relaxari, — cùm capsula cordis omnino connectendum suit, in Homine,
ne fortè, quamdiu ere tus incedit, ab Hepatis, aliorumque viscerum appensorum pondere deorsum aded deprimeretur, ut neque Pulmo satis
concidere, neque Exspiratio debito modo peragi potuerit. Quocirca in
Quadrupedibus, ubi abdominis viscera in ipsum Diaphragma incumbunt,
ipsumque in pettoris cavitatem suo pondere impellunt, ista partium accretic Exspirationi quidem inutilis, Inspirationi autem debitam Diaphragmatis tensionem impediendo, prorsus incommoda suisset. Lower,
ib. p. 8.

334 Of the Difference Book VI. "Go": To express it in the Words of a great Judge

in such Matters (i).

(i) Dr. Tyson's Anatomy of the Orang-Outang, in Ray's Wisdom of God, p. 262.

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CHAP. VI.

Of the Difference between Man and Quadrupeds in the Nervous Kind.

THERE is only one Difference more between Man and Quadrupeds that I shall take notice of, and that is the Nervous Kind: And because it would be tedious to insist upon many Particulars (a), I shall, for a Sample, insist chiefly upon one, and that is, of Nature's prodigious Care for a due Communication and Correspondence between the Head and Heart of Man, more than what is in the four-tooted Tribe. For this Purpose, besides the Correspondence those Parts have by Means of the Nerves of the Par vagum (common both to Man and Beast) there is a farther and more special Communication and Correspondence occasioned by the Branches (b) of the intercostal Pair sent from the Cervical

(b) In plerisque Brutis tantum hâc viâ (i. e. by the Par wagum) & vix omnino per ullos Paris Intercostalis nervos, aditus ad cor aut Appendicem ejus pateseit. Verum in Homine, Nervus Intercostalis, pra-

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⁽a) Amongst these, I might name the Site of the Nerves proceeding from the Medulla Spinalis, which Dr. Lower takes notice of. In Beasts, whose Spine is above the rest of the Body, the Nerves tend directly downwards; but in Man, it being erect, the Nerves spring out of the Spine, not at Right, but in Oblique Angles downwards, and passalso in the Body the same Way. Ibid. p. 16.

Cervical Plexus to the Heart, and Pracordia. By which Means the Heart and Brain of Man have a mutual and very intimate Correspondence and Concern with each other, more than is in other Creatures; or as one of the most curious Anatomists and Observers of these Things saith (c): Brutes are as it were Machines made with a fimpler, and less operose Apparatus, and endowed therefore with only one and the same Kind of Motion, or determined to do the same Thing: Whereas in Man, there is a great Variety of Motions and Actions. For by the Commerce of the aforesaid Cervical Plexus (d) he saith, The Conceptions of the Brain presently affect the Heart, and agitate its Vessels and whole Appendage, together with the Diaphragm. From whence the Alteration in the Motion of the Blood, the Pulse, and Respiration. So also on the contrary, when any Thing affects or alters the Heart, those Impressions are not only retorted to the Brain by the same Duct of the Nerves, but also the Blood it self (its Course being once " changed)

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(c) Id. ib. Dum hanc utriusque speciei differentiam perpendo, suc-

officia ejus in imo ventre huic cum cateris animalibus communia, am ante pectoris claustra internuncii specialis loco est, qui Cerebri Sondis sensa mutua ultra citraque refert. Willis Nervor. descr. usus, c. 26.

⁽d) That our great Man was not mistaken, there is great eason to imagine, from what he observ'd in dissecting a bol. Besides the Brain being but small, he saith, Pracipua tem discriminis nota quam inter illius & viri cordati partes advertius, bacce erat; nempe quod pradictus Nervi Intercostalis Plexus, em Cerebri & Cordis internuncium & Hominis proprium diximus, Stulto hoc valde exilis, & minori Nervorum satellitio stipatus suerit. bid.

336 The Nervous Kind, &c. Book VI.

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changed) flies to the Brain with a different and " unusual Course, and there agitating the Animal Spirits with divers Impulses, produceth various "Conceptions and Thoughts in the Mind." And he tells us, "That hence it was that the Ancient "Divines and Philosophers too, made the Heart " the Seat of Wisdom; and certainly (faith he) " the Works of Wisdom and Virtue do very much depend upon this Commerce which is between " the Heart and Brain:" And so he goeth on with more to the same Purpose. Upon the Account of this Intercostal Commerce with the Heart, being wanting in Brutes, there is another fingularly careful and wife Provision the Infinite Creator hath made in them, and that is, That by Reason both the Par Vagum, and the Intercostal too, do not fend their Branches to the Heart, and its Appendage in Brutes; therefore, lest their Heart should want a due Proportion of Nervous Vessels, the Par Vagum fends more Branches to their Heart than to that of Man. This, as it is a remarkable Difference between Rational and Irational Creatures; so it is as remarkable an Argument of the Creator's Art and Care; who although he hath denied Brute-Animals Reason, and the Nerves ministring thereto, yet hath another Way fupplied what is necessary to their Life and State But let us hear the same great Author's Descan upon the Point (e); "Inafmuch, faith he, " Beasts are void of Discretion, and but little subi ject to various and different Passions, therefor " there was no Need that the Spirits, that weren

⁽e) Id. ib. cap. 29. In quantum Bestia prudentid carent, & varil diversisque passionibus, &c. 66 be

" be convey'd from the Brain to the Pracordia, flould pass two different Ways, namely, one for

"the Service of the vital Functions, and another

" for the reciprocal Impressions of the Affections;

" but it was sufficient that all their Spirits, what-

" ever Use they were designed for, should be con-

" veyed one and the fame Way.

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Here now in the Nervous Kind we have manifest Acts of the Creator's Design and Wisdom, in this so manifest and distinct a Provision for Rational and Irrational Creatures; and that Man was evidently intended to be the one, as the Genus of Quadrupeds was the other.

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C H A P. VII. The CONCLUSION.

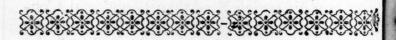
ND now it is Time to pause a while, and re-A flect upon the Whole. And as from the Confiderations in the preceding Book, we have especial Reason to be thankful to our Infinitely Merciful Maker, for his no less Kind than Wonderful Contrivances of our Body; so we have Reason, from this brief View I have taken of this last Tribe of the Creation, to acknowledge and admire the Same Creator's Work and Contrivances in them. For we have here a large Family of Animals, in every particular Respect, curiously contrived and made, for that especial Posture, Place, Food, and Office or Business which they obtain in the World. So that if we confider their own particular Happiness and Good, or Man's Use and Service; or if we view them

them throughout, and confider the Parts wherein they agree with Man, or those especially wherein they differ, we shall find all to be so far from bes ing Things fortuitous, undefigned, or any Way accidental, that every Thing is done for the best; all wifely contrived, and incomparably fitted up, and every Way worthy of the Great Creator. And he that will shut his Eyes, and not see God (a) in these His Works, even of the poor Beasts of the Earth, that will not say [as Elibu hath it, 70b XXXV. 10, 11.] Where is God my Maker, who teacheth us more than the Beafts of the Earth, and maketh us wiser than the Fowls of the Heaven? Of fuch an one we may use the Pfalmist's Expression, Pfal. xlxix. 12. That he is like the Beasts (b) that perish.

(a) — Deum namque ire per omnes
Terrasque trastusque Maris, Cœlumque profundum.
Hinc Pecudes, Armenta, viros, genus omne Ferarum.

Virgil. Georg. 1. 4.

(b) Illos qui nullum omnino Deum esse dixerunt, non modo non Philosophos, sed ne homines quidem suisse dixerim; qui, mutis simillimi, ex solo corpore constiterunt, nihil videntes animo. Lactant. 1. 7. c. 9.



BOOK VII.

ASURVEY of BIRDS.

Aving briefly, as well as I could, difpatch'd the Tribe of Quadrupeds; I shall next take as brief and transient a View of the Feather'd Tribe.

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CHAP. I. Motion and Parts of Birds. 339

And here we have another large Province to expatiate in, if we should descend to every Thing wherein the Workmanship of the Almighty appears. But I must contract my Survey as much as may be; and shall therefore give only such Hints and Touches upon this curious Family of Animals, as may serve for Samples of the rest of what might be observ'd..

CHAP. I.

Of the Motion of Birds, and the Parts miniftring thereto.

A S this Tribe hath a different Motion from that of other Animals, and an amphibious Way of Life; partly in the Air, and partly on the Land and Waters; so is their Body accordingly shap'd, and all their Parts incomparably sitted for that Way of Life and Motion; as will be found by a cursory View of some of the Particulars. And the

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I. And most visible Thing, is the Shape and Make of their Body, not thick and clumfy, but incomparably adapted to their Flight: Sharp before, to pierce and make Way through the Air, and then by gentle Degrees rising to its full Bulk. To which we may add,

II. The neat Position of the Feathers throughout the Body; not rusted, or discomposed, or placed ome this, some a contrary Way, according to the sethod of Chance; but all artificially placed (a),

⁽a) See before Book IV. Chap. 12. Note (1):

for facilitating the Motion of the Body, and its Security at the same Time, by way of Cloathing: And for that End, most of the Feathers tend backward, and are laid over one another in exact and regular Method, armed with warm and soft Down next the Body, and more strongly made, and curiously clos'd next the Air and Weather, to sence off the Injuries thereof. To which Purpose, as also for the more easy and nimble gliding of the Body through the Air, the Provision Nature hath made, and the Instinct of these Animals to preen and dress their Feathers, is admirable; both in Respect of their Art and Curiosity in doing it, and the Oil-bag (b), Glands, and whole Apparatus for

III. And now having faid thus much relating to the Body's Motion, let us Survey the Grand Instrument thereof, the Wings. Which as they are principal Parts, so are made with great Skill, and placed in the most commodious Point of the Body (c).

that Service.

(b) Mr. Willughby faith, there are two Glands for the Secretion of the unctuous Matter in the Oil-bag. And so they appear to be in Geese. But upon Examination, I find, that in most other Birds, (such at least as I have enquired into, there is only one Gland; in which are divers little Cells, ending in two or three larger Cells, lying under the Nipple of the Oil-bag. This Nipple is perforated, and being pressed, of drawn by the Bird's-Bill, or Head, emits the liquid Oil, ask is in some Birds, or thicker unctuous Grease, as it is in thers. The whole Oil-bag is in its Structure somewhat conformable to the Breasts of such Animals as afford Milk.

(c) In all Birds that fly much, or that have the most Occafion for their Wings, it is manifest that their Wings are place in the very best Part, to balance their Body in the Air, and a give as swift a Progression, as their Wings and Body are capable of: For otherwise we should perceive them to reel, and sty unsteadily; as we see them to do, if we alter their Æqui-

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CHAP. I. The Wings of Birds.

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And here it is observable, with what incomparable Curiofity every Feather is made; the Shaft exceeding strong, but hollow below, for Strength and Lightness Sake; and above, not much less strong, and fill'd with a Parenchyma or Pith, both strong and light too. The Vanes as nicely gaug'd on each Side as made; broad on one Side, and narrower on the other; both which incomparably minister to the progressive Motion of the Bird, as also to the Union and Closeness of the Wing (d).

And

poife, by cutting the End of one of the Wings, or hanging a Weight at any of the extreme Parts of the Body. But as for fuch Birds as have as much Occasion for Swimming as Flying, and whose Wings are therefore set a little out of the Centre of the Body's Gravity. See Book IV. Chap. 8. Note (q). And for fuch as have more Occasion for Diving than Flying, and whose Legs are, for that Reason, set more backward, and their

Wings more forward. Chap. 4. Note (k) of this Book.

(d) The Wife Author of Nature hath afforded an Example of the great Nicety in the Formation of Birds, by the Nicety observed in a Part no more considerable than the Vanes of the Flag-feathers of the Wing. Among others, these two Things are observable: 1. The Edges of the exterior or narrow Vanes bend downwards, but of the interior wider Vanes upwards; by which Means they catch, hold, and lie close to one another, when the Wing is spread; fo that not one Feather may miss its full Force and Impulse upon the Air. 2. A yet leffer Nicety is observ'd, and that is, in the very floping the Tips of the Flag-feathers: The interiour Vanes being neatly flop'd away to a Point, towards the outward Part of the Wing; and the exteriour Vanes flop'd towards the Body, at least in many Birds; and in the Middle of the Wing, the Vanes being equal, are but little flop'd. So that the Wing, whether extended or shut, is as neatly flop'd and form'd, as if constantly trimm'd with a Pair of Sciffors.

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And no less exquisite is the textrine Art of the *Plumage* (e) also; which is so curiously wrought, and so artificially interwoven, that it cannot be viewed without Admiration; especially when the Eve is affished with Glasses.

And as curiously made, so no less curiously are the Feathers placed in the Wing, exactly according to their several Lengths and Strength: The Principals set for Stay and Strength, and these a-

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(e) Since no exact Account, that I know of, hath been given of the Mechanism of the Vanes, or Webs of the Feathers, my Observations may not be unacceptable. The Vane confists not of one continu'd Membrane; because if one broken, it would hardly be reparable: But of many Lamina, which are thin, stiff, and somewhat of the Nature of a thin Ouill. Towards the Shaft of the Feather, (especially in the Flagfeathers of the Wing,) those Lamina are broad, &c. of a femicircular Form; which ferve for Strength, and for the closer shutting of the Lamina to one another, when Impulses are made upon the Air. Towards the outward Part of the Vane, these Lamina grow slender and taper: On their under Side they are thin and smooth, but their upper-outer Edge is parted into two hairy Edges, each Side having a different Sort of Hairs, laminated or broad at Bottom, and slender and bearded above the other half. I have, as well as I could, represented the uppermost Edge of one of these Lamina in Fig. 18. with some of the Hairs on each Side, magnify'd with a Microscope, These bearded Bristles, or Hairs, on one Side the Lamina, have strait Beards, as in Fig. 19. those on the other Side, have hook'd Beards on one Side the flender Part of the Briftle, and strait ones on the other, as in Fig. 20. Both these Sorts of Briftles magnify'd, (only scattering, and of the Lamina f. t. in Fig. 18. And in the Vane, the hook'd Beards of one Lamina, always lie next the strait Beards of the next Lamina; and by that Means lock and hold each other; and by a pretty Mechanism, brace the Lamina close to one another. And if at any Time the Vane happens to be ruffled and discompos'd, it can by this pretty easy Mechanism, be reduc'd and repair'd. Vid. Book IV. Chap. 12. Note (m). (f) Pettagain well lined, faced, and guarded with the Covert and Secondary Feathers, to keep the Air from passing through, whereby the stronger Im-

pulses are made thereupon.

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And lastly, to say no more of this Part, that deserves more to be said of it, what an admirable Apparatus is there of Bones, very strong, but withal light and incomparably wrought? of Joynts, which open, shut, and every way move, according to the Occasions either of extending it in Flight, or withdrawing the Wing again to the Body? And of various Muscles; among which the peculiar Strength of the Pectoral Muscles deserves especial Remark, by Reason they are much stronger (f) in Birds than in Man, or any other Animal, not made for Flying.

IV. Next the Wings, the Tail is in Flight confiderable; greatly affifting in all Ascents and Descents in the Air, as also serving to steady (g)

Flight,

Mr. Willughby having made the like Observation, bath this Respection on it, whence, if it be possible for a Man to fly, it is thought by them who have curiously weighed and considered the matter, that he that would attempt such a Thing with Hopes of Success, must so contrive and adapt his Wings, that he may make use of his Legs, and not his Arms in managing them: (because the Muscles of the Legs are stronger, as he observes.) Willugh, Ornith, 1, 1. c. 1. sect. 19.

(g) Mr. Willughby, Ray, and many others, imagine the principal Use of the Tail to be to steer, and turn the Body in the Air, as a Rudder. But Borelli hath put it beyond all Doubt, that this is the least Use of it, and that it is chiefly to

⁽f) Pettorales Musculi Hominis stettentes humeros, parvi & parum carnosi sunt; non aquant 50am aut 70am partem omnium Musculorum Hominis. E contra in Avibus, Pettorales Musculi vastissimi sunt, & aquant, imò excedunt, & magis pendent, quam reliqui omnes Musculi ejusdem Avis simul sumpti. Borell. de Mot. Animal. Vol. I. Prop. 184.

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Flight, by keeping the Body upright in that subtile and yielding *Medium*, by its readily turning and

answering every Vacillation of the Body.

And now to the Parts serving to Flight, let us add the nice and compleat Manner of its Performance; all done according to the strictest Rules of Mechanism (b). What Rower on the Waters, what Artist on the Land, what acutest Mathematician could give a more agreeable and exact Motion to the Wings, than these untaught slying Artists do theirs! Serving not only to bear their Bodies up in the Air, but also to wast them along therein, with a speedy progressive Motion, as also to steer and turn them this Way and that Way, up and down, faster or slower, as their Occasions require, or their Pleasure leads them.

V. Next to the Parts for Flight, let us view the Feet and Legs ministring to their other Motion: Both made light, for easier Transportation through the Air; and the former spread, some with Membranes for Swimming (i), some without, for steady

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affift the Bird in its Afcents and Descents in the Air, and to obviate the Vacillations of the Body and Wings. For, as for turning to this or that Side, it is performed by the Wings and Inclination of the Body, and but very little by the help of the Tail.

⁽b) See Borelli ubi supr. Prop. 182, Sec.

⁽i) It is confiderable in all Water-Fowl, how exactly their Legs and Feet correspond to that way of Life. For either their Legs are long, to enable them to wade in the Waters. In which case, their Legs are bare of Feathers a good way above the Knees, the more conveniently for this Purpose. Their Toes also are all abroad; and in such as bear the Name of Mudsuckers, two of the Toes are somewhat joined, that they may not easily fink in walking upon boggy Places. And as for such as are whole-footed, or whose Toes are

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es are ebbed Going, for Perching, for Catching and Holding of Prey (k), or for Hanging by the Heels to gather their Food (1), or to fix themselves in their Places of Retreat and Safety. And the latter, namely the Legs, all curved for their easy Perching, Roosting, and Rest, as also to help them upon their Wings in taking their Flight, and to be therein commodiously tucked up to the Body, so as not to obstruct their Flight. In some long, for Wading and Searching the Waters; in some of a moderate Length, answerable to their vulgar Occasions; and in others as remarkably short, to answer their especial Occasions and Manner of Life (m). To all these let us add the placing these last mentioned

webbed together (excepting some few) their Legs are generally short, which is the most convenient Size for Swimming. And 'tis pretty enough to see how artificially they gather up their Toes and Feet when they withdraw their Legs, or go to take their Stroke; and as artificially again extend or open their whole Foot, when they press upon, or drive themselves forward in the Waters.

(k) Some of the Characteristicks of Rapacious Birds, are, to have hooked, strong, and starp-pointed Beaks and Talons, stitled for Rapine, and tearing of Fless; and strong and brawny Thighs, for striking down their Prey. Willughby Ornith. l. 2. c. 1. Raii Synops. Av. Method. p. 1.

(1) Such Birds as climb, particularly those of the Wood-pecker Kind, have for this Purpose (as Mr. Willinghby observes, l. 2. c. 4.) 1. Strong and musculous Thighs. 2. Short Legs and very strong. 3. Toes standing two forwards and two backwards. Their Toes also are close joined together, that they may more strongly and firmly lay hold on the Tree they climb upon. 4. All of them—have a hard stiff Tail bending also downwards, on which they lean, and so bear up themselves in climbing.

(m) Swifts and Swallows have remarkably short Legs especially the former, and their Toes grasp any Thing very strongly. All which is useful to them in building their Nests, and other such Occasions as necessitate them to hang fre-

The Heads of Birds. BOOK VII. 346 tioned Parts in the Body. In all somewhat out of the Centre of the Body's Gravity (n), but in such as fwim, more than in others, for the better row. ing their Bodies through the Waters, or to help them in that Diving (0) too.

quently by their Heels. But there is far greater Use of this Structure of their Legs and Feet, if the Reports be true of their hanging by the Heels in great Clusters (after the manner of Bees) in Mines and Grotto's, and on the Rocks by the Sea, all the Winter. Of which latter, I remember the late learned Dr. Fry told this Story at the University, and confirmed it to me fince, viz. That an ancient Fisherman, accounted an honest Man, being near some Rocks on the Coast of Cornwal faw at a very low Ebb, a black List of something adhering to the Rock, which when he came to examine, he found it was a great Number of Swallows, and, if I mifremember not, of Swifts also, hanging by the Feet to one another, as Bees do; which were covered commonly by the Sea-Waters, but revived in his warm Hand, and by the Fire. All this the Fisherman himself assured the Doctor of. Of this, see more, Chap. 2. Note (d) of this Book.

(n) In Birds that frequent not the Waters, the Wings are in the Center of Gravity, when the Bird lies along, as in Flying; but when it stands or walks, the Erection of the Body throws the Center of Gravity upon the Thighs and Feet.

(0) See Chap. 4. Note (k).

CHAP. II.

Of the Head, Stomach, and other Parts of BIR DS.

HUS having dispatched the Parts principally concerned in the Motion of the Feather'd Tribe, let us proceed to some other Parts not yet animadverted upon. And we will begin with the Head, concerning which I have already taken no-

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CHAP. II. The Heads of Birds.

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tice of its Shape for making way through the Air; of the Make of the Bill, for gathering Food, and other Uses; the commodious Situation of the Eye; and I might add that of the Ear too, which would be in the Way, and obstruct Flight, if 'twas like that of most other Animals: Also I might say a great deal of the Conformation of the Brain, and of the Parts therein wanting, and of others added, like to what is observable in Fishes; whose Posture in the Waters resembles that of Birds in the Air (a), and both very different from Man and Beasts; and lastly, to hint at no more, I might survey the peculiar Structure of the Larynx (b), the Tongue,

(b) Circa bifurcationem Afpera Arteria, elegans Artificis libere agentis indicium detegitur ex Avium comparatione cum Quadrupedibus:
cum Vocis gratia in diversis Avibus diversam musculorum fabricam bifurcationi Afpera Arteria dederit, quorum nullum vestigium extat in
Homine & Quadrupedibus mibi visis, ubi omnes vocis musculos capiti
Arteria junxit. In Aquila, &c. supra bifurcationem, &c. Steno

in Blaf, Anat. Animal. p. 2. c. 4.

The Aspera Arteria is very remarkable in the Swan, which is thus described by T. Bartholin, viz. Aspera Arteria admiranda satis structura. Nam pro Colli longitudine deorsum Oesophagi comes protenditur donec ad sternum perveniat, in cujus capsulam se incurvo sexu insinuat & recondit, velut in tuto loco & thecâ, moxque ad sundum ejusdem cavitatis delata sursum restectitur, egrediturque angustias Sterni, & Claviculis mediis concensis, quibus ut sulcro nititur, ad Thoracem se steetit—Miranda hercle modis omnibus constitutio & Respirationi inservit & Voci. Nam cum in stagnorum sundo edulia pro victu querat, longissimo indiguit collo, ne longa mora sussocianis incurreret periculum. Et certe dum dimidiam sere horam toto Capite & Collo pronis vado immergiter, pedibus in altum elatis caloque obversis, ex cu Arteria

⁽a) Cerebra Hominum & Quadrupedum in plerisque similia existunt.

Capitibus Volucrum & Piscium contenta, ab utrisque prioribus longe diversa, tamen inter se, quoad pracipuas in partes Symbola repersuntur. The Particulars wherein the Brains of Birds and Fishes agree with one another, and wherein they differ from the Brain of Man and Beasts, see in the same justly famous Author, Willis Cereb. Anat. c. 5.

348 The Heads of Birds. Book VII. Tongue (c), the inner Ear (d), and many Matters besides;

Arteria qua pectoris dicta vagina reclusa est portione, tanquam ex

condo promo spiritum baurit. Blas. ib. c. 10.

(c) The Structure of the Tongue of the Wood-Pecker is very fingular and remarkable, whether we look at its great Length. its Bones and Muscles, its encompassing Part of the Neck and Head, the better to exert it felf in Length; and again, to retract it into its Cell; and lastly, whether we look at its sharp, horny, bearded Point, and the glewy Matter at the End of it, the better to stab, to stick unto, and draw out little Maggots out of Wood. Utilis enim Picis (faith Coi. ter) ad Vermiculos, Formicas, aliaque Insecta venanda talis Lingua Siquidem Picus, innata sua sagacitate cum deprehendit alibi in arboribus, vel carie, vel alia de causa cavatis. Vermes insectaque deli. tescere, ad illas volitat, seseque digitis, ungulisque posterioribus robustis. simis, & Cauda pennis rigidissimis sustentat, donec valido ac peracuti Rostro arborem pertundat : arbore pertusa, foramini rostrum immitit, ac quo animacula stridore excitet percellatque, magnam in arboris casa emittit vocem, insecta veciferatione bac concitata buc illucque repunt; Picus v. linguam suam exerit, atque aculeis, hamisque animalia inf. git, infixa attrahit & devorat. Vid. Blafii ubi fupra, p. 2. c. 24,

(d) I have before in Book IV. Chap. 3. Note (u), taken notice of what others have observed concerning the inner Em of Birds, reserving my own Observations for this Place: Which I hope may be acceptable, not only for being some of them new, but also shewing the Mechanism of Hearing in

General.

In this Organ of Birds, I shall take notice only of three Parts, the Membranes and Cartilages; the Columella; and the Conclave: The Drum, as some call it, or Membrana Tympani, as others, confifts of two Membranes, the Outer, which coven the whole Meatus, Bason or Drum, (as some call it) and the inner Membrane. To support, distend and relax the outermost, there is one fingle Cartilage, reaching from the Side of the Meatus, to near the middle of the Membrane. Un the top of the Columella is another Cartilage, confifting of three Branches, a.b.c. in Fig. 23. The longest middle Branch a, is joined to the top of the fingle upper Cartilage before spoken of, and affists it to bear up the upper-outer Membrane: The two Branches, b. e. are joined to the Os Petro fum, at some Distance from the outer Membrane: Upon this inner Cartilage, is the inner Membrane fixed, the two outer Sides of which a. b. and a. e. are joined to the outer Membrane, and made a kind of three-square Bag.

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Defign of the two Branches or Legs of the Cartilage, b. c. are, I conceive, to keep the Cartilage and Columella from wavering Side-ways, and to hinder them from flying too much back: There is a very fine flender Ligament extended from the opposite Side, quite cross the Meatus or Bason, to the Bottom of the Cartilage, near its joining to the Columella. Thus

much for the Membrana Tympani, and their Cartilages.

The next Part is the Columella (as Schelhammer calls it.) This is a very fine, thin, light, bony Tube; the Bottom of which spreads about, and gives it the Resemblance of a wooden Pot-lid, such as I have seen in Country-Houses. It exactly shuts into, and covers a Foramen of the Conclave, to which it is braced all round, with a sine subtile Membrane, composed of the tender Auditory Nerve. This Bottom or Base of

the Columella, I call the Operculum.

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The last Part, which some call the Labyrinth and Cochlea, consisting of Branches more like the Canales Semicirculares in Man, than the Cochlea, I call the Conclave Auditus. It is (as in most other Animals) made of hard context Bone. In most of the Birds I have opened, there are circular Canals, some larger, some lesser, crossing one another at right Angles, which open into the Conclave. But in the Goose it is otherwise, there being cochleous Canals, but not like those of other Birds. In the Conclave, at the Side opposite to the Operculum, the tender Part of the Auditory Nerve enters, and lineth all those inner retired Parts, viz. the Conclave and Canals.

As to the Passages, Columna, and other Parts observable in the Ear of Birds, I shall pass them by, it being sufficient to my Purpose, to have described the Parts principally concerned in the Act of Hearing. And as the Ear is in Birds the most simple and incomplex of any Animals Ear; so we may from it make an easy and rational Judgment, how Hearing is performed, viz. Sound being a Tremor, or Undulation in the Air, caused by the Collision of Bodies, doth, as it moves along, strike upon the Drum, or Membrana Tympani of the Ear. Which Motion, whether strong or languid, shrill, or soft, tuneful or not, is at the same Instant impressed upon the Cartilages, Columella, and Operculum, and so communicated to the Auditory Nerve in the Conclave.

And now if we compare the Organ and Act of Hearing, with those of Sight, we shall find that the Conclave is to Hearing, as the Retina is to Sight; that sonorous Bodies make their Impressions thereby on the Brain, as visible Objects do by the Retina. Also, that as there is an Apparatus in the Eye, by the opening and shutting of the Pupil, to make it corre-

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The Heads of Birds. BOOK VII. 350

besides; but for a Sample, I shall only insist upon the wonderful Provision in the Bill for the judging of the Food, and that is by peculiar Nerves lodged therein for that Purpose; small and less numerous in fuch as have the Affistance of another Sense, the Eye; but large, more numerous, and thickly branched about, to the very End of the Beak, in fuch as hunt for their Food out of Sight in the Waters, in Mud, or under Ground (e).

found to all the Degrees of Light, fo there is in the Ear, to make it conformable to all the Degrees of Sound, a noble Train of little Bones and Muscles in Man, &c. to strain and relax the Membrane, and at the fame Time to open and shut the Basis of the Stapes (the same as what I call the Operculum in Birds:) But in Birds there is a more simple, but sufficient Apparatus for this Purpose, tender Cartilages, instead of Bones and Joints, to correspond to the various Impressions of Sounds, and to open and flut the Operculum. Besides which, I suspect the Ligament I mention'd, is only the Tendon of a Muscle, reaching to the inner Membrana Tympani, and joined thereto (as I find by a stricter Scrutiny) and not to the Cartilage, as I imagined. By this Muscle, the inner Membrane, and by Means of that the Outer also, can be distended or relaxed, as it is in Man, by the Malleus and its Muscle, &c.

(e) Flat-billed Birds, that grope for their Meat, have three Pair of Nerves, that come into their Biks, whereby they have that Accuracy to distinguish what is proper for Food, and what to be rejected by their Taste, when they do not see it. This was most evident in a Duck's Bill and Head; Ducks having larger Nerves that come into their Bills than Geefe, or any other Bird that I have feen; and therefore quaffer and grope out their Meat the most. But then I discovered none of these Nerves in round-bill'd Birds. But since, in my Anatomies in the Country, in a Rook, I first observed two Nerves that came down betwist the Eyes into the upper Bill, but considerably smaller than any of the three Pair of Nerves in the Bills of Ducks, but larger than the Nerves in any other round-bill'd Birds. And it is remarkable that these Birds, more than any other round-bill'd Birds, feem to Grope for their Meat in Cow-dung, &c. Mr. J. Clayton, in Philos. Trans.

I observed three Pair of Nerves in all the broad-billed Birds that I sould meet with, and in all such as feel for their Food out of Sight, as Snipes, Woodcocks, Curlews, Geefe, Ducks, Teals, Widgeons, &c.

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CHAP. II. The Stomach of Birds. 351

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And now from the Head and Mouth, pass we to its near Ally, the Stomach, another no less notable than useful Part; whether we consider the Elegancy of its Fibres and Muscles, or its Multiplicity; one to soften and macerate, another to digest; or its Variety, suited to various Foods, some membranous, agreeable to the frugivorous, or carnivorous Kind; some musculous and strong (f), suited to the Comminution, and grinding of Corn and Grain, and so to supply the Defect of Teeth.

And now to this Specimen of the Parts, I might add many other Things, no less curiously contriv'd, made and suited to the Occasions of these Volatiles; as particularly the Structure and Lodgment of the Lungs (g); the Configuration of the

Breaft,

These Nerves are very large, equalling almost the Optic Nerve in Trickness.—Iwo are distributed nigh the End of the upper Bill, and are there very much expanded, passing through the Bone into the Membrane, ming the Roof of the Mouth. Dr. A. Moulen, Ibid. No. 199. Or both in Mr. Lowthorp's Abridg. v. 2. p. 861, 862.

(f) The Gizzard is not only made very strong, especially in the Granivorous; but hath also a Faculty of Grinding what is therein. For which Purpose, the Bird swalloweth rough Stones down, which when grown smooth, are rejected and cast out of the Stomach, as useless. This Grinding may be heard in Falcons, Eagles, &c. by laying the Ear close to them, when their Stomachs are empty, as the samous Dr. Harvey with. De Generat. Exer. 7.

As to the Strength of the Gizzard, and the Use of Stones to the Digestion of Fowls, divers curious Experiments may be met with, try'd by Seigneur Redi, with Glass-Bubbles, solid Glass, Diamonds, and other hard Bodies. See his Exp. Nat.

(g) It is no less remarkable in Birds, that their Lungs adere to the Thorax, and have but little Play, than that in other Animals they are loose, and play much, which is a good Provision for their steady Flight. Also they want the Diabragm, and instead thereof, have divers large Bladders made of thin transparent Membranes, with pretty large Holes out of the into the other. These Membranes seem to me to serve

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Breast, and its Bone, made like a Keel, for commodious Passage through the Air, to bear the large and strong Muscles, which move the Wings, and to counterpose the Body, and support and rest it upon at Roost. The Neck also might deserve our Notice, always either exactly proportion'd to the Length of the Legs, or else longer, to hunt out Food, to search in the Waters (b); as also to counterpose the Body in Flight (i). And lastly, I might here take Notice of the Desect of the Diaphragm,

for Ligaments, or Braces to the Viscera, as well as to contain 'Air. Towards the upper Part, each Lobe of the Lungs's perforated in two Places, with large Perforation; whereof one is towards the outer, the other towards the inner Pant of the Lobe. Through these Perforations, the Air hathat Passage into the Belly, (as in Book I. Chap. 1. Note (b);) that is, into the foremention'd Bladders; so that by blowing into the Aspera Arteria, the Lungs will be a little rais'd, and the whole Belly blown up, so as to be very turgid. Which doubtes is a Means to make their Bodies more or less buoyant, according as they take in more or less Air, to facilitate there by their Ascents, and Descents: Like as it is in the Air-bladders of Fishes, in the last cited Place, Note (1).

(b) Such Birds as have long Legs, have also a long Neck; for that etherwise they could not commediously gather up their Food, either a Land, or in the Water. But on the other Side, those which have long Necks, have not always long Legs, as in Swans—whose Necks serve them to reach to the Bottom of Rivers, &c. Willughby's Ornithal

1. 1. c. 1. fect. 7.

(1) We have sufficient Instances of this in Geese, Ducks, & whose Wings, (their Bodies being made for the Convenience of Swimming,) are placed out of the Centre of Gravity, nearer the Head. But the extending the Neck and Head in Flight, causeth a due Æquipoise and Libration of the Bod upon the Wings; which is another excellent Use of the loss Necks of these Birds, besides that of reaching and searching in the Waters for their Food.

But in the Heron, whose Head and long Neck, (although tuck'd up in Flight,) overbalance the hinder Part of the Body; the long Legs are extended in Flight, to counterposses Body, as well as to supply what is wanting in the Tail, from the Shortness of it.

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fo necessary in other Animals to Respiration; and also of divers other Parts redundant, defective, or varying from other Animals. But it would be tedious to insist upon all; and therefore to the Examples already given, I would rather recommend a nice Inspection (k), of those curious Works of God, which would be manifest Demonstrations of the admirable Contrivance and Oeconomy of the Bodies of those Creatures.

From the Fabrick therefore of their Bodies, I shall pass to a Glance of one or Two Things, relating to their *State*; and so conclude this Genus of the Animal World.

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CHAP. III. Of the Migration of BIRDS.

Concerning the State of this Tribe of Animals, the first Thing I shall speak of, (by Reason God himself instanceth in it,) shall be their Migration, mention'd, Fer. viii. 7. Yea, the Stork in the Heaven knoweth her appointed Times, and the Turtle, and the Crane, and the Swallow observe the Time of their Coming; but my People, &c.

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⁽k) Steno thus concludes his Myology of the Eagle, Imperfect a hac Musculorum descriptio, non minus arida est Legentibus, quam Inspectantibus suerit jucunda eorundem praparatio. Elegantissima enim Mechanices artissicia, creberrime in illis obvia, verbis non nisi obscure exprimuntur, carnium autem dustu, tendinum colore, insertionum proportione, & trocklearum distributione oculis exposita omnem superant admirationem. Steno in Blas. Anat. Animal. p. 2. c. 4.

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In which Act of Migration, there are two Things to me exceedingly notable. One is what the Text speaks of, their knowing their proper Times for their Passage, when to come (a), when to go; as also that some should come when others go; and fome others go when these come. There is no doubt but the Temperature of the Air, as to Heat and Cold, and their natural Propenfity to breed their Young, may be great Incentives to those Creatures to change their Habitation: But yet it is a very odd Instinct, that they should at all shift their Habitation; that some certain Place is not to be found in all the Terraqueous Globe, affording them convenient Food and Habitation all the Year, either in the colder Climes, for fuch as delight in the colder Regions; or the hotter, for fuch Birds of Paffage as fly to us in Summer.

Alfo it is somewhat strange, that those untaught, unthinking Creatures, should so exactly know the best and only proper Seasons to go and come. This gives us good Reason to interpret the מועריה appointed Times (b), in the Text, to be such Times as the Creator hath appointed those Animals, and hath accordingly, for this End, imprinted upon their Natures such an Instinct, as exciteth and moveth

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(b) From 70' indixit, constituit, scil. locum, vel tempus, ubi al quando aliquid sieri debet. Buxt. in verb.

⁽a) Curiosa res est, scire, quam exacte hoc genus avium [Gruum] quotannis observet tempora sui reditus ad nos. Anno 1667, prime Grues comparuerunt in campestribus Pisa 20 Feb. &c. F. Redi Exp. Nat. p. 100. ubi plura.

De voluntate sua certierem reddidit. Con. Kircher concordant.
Pars. 1. Col. 1846. 7912 Generaliter pro re aliqua certă, attestată, & definită accipitur. 1. Pro tempore certo & constituto. 2.
Deinde pro sesto solennitate, qua certo & sato tempore celebratur. 3.
Pro loco certo constituto. Id. Ibid. Col. 1847. (c) Quis

Migration of Birds. CHAP. III.

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them this, at proper Times, to fly from a Place hat would obstruct their Generation, or not afford convenient Food for them, and their Young, and betake themselves to another Place, affording all

hat is wanting for Food or Incubation.

And this leads me to another Thing remarkable n this Act of Migration; and that is, That those nthinking Creatures should know what Way to teer their Course (c), and whither to go. ut the Great Creator's Instinct should ever move a oor foolish Bird, to venture over vast Tracts of and, but especially over large Seas? If it should e faid, That by their high Ascents up into the Air, hey can fee cross the Seas; yet what should teach perswade them, that that Land is more proper or their Purpose, than this? That Britain, (for oftance,) should afford them better Accommodations than Agypt (d), than the Canaries, than Spain,

(c) Quis non cum admiratione videat ordinem & politiam peregrintium Avium, in itinere, turmatim volantium, per longos terrarum maris tractus absque Acu marina? - Quis eas certum iter in is mutabili regione docuit? Quis praterita signa, & futura via inia? Quis eas duvit, nutrit, & vita necessaria ministrat? Quis inas & kospitia illa, in quibus victum reperiant, indicavit; modumque smodi loca in peregrinationibus suis inveniendi? Hac sane superant koum captum 😌 industriam, qui non nisi longis experientiis, multis erariis, charti: geographicis, — 😂 acûs magnetica beneficio. — 🛎 smedi marium & terrarum tractus conficere tentant & audent; d. de Beaufort. Cosmop. divina Sect. 5. Cap. 1.

⁽d) I instance particularly in Ægypt, because Mr. Williaghby nks Swallows fly thither, and into Athiopia, &c. and that ey do not lurk in Holes, or under Water, as Olaus Magnus ports. Vide Ornith. lib. 2. cap. 3. But Etmuller puts the atter out of Doubt; who faith, Memini me pluves, quam quas Medimnus caperit, Hirundines arete coacervatas intra Piscina cannas, attel paglacie prorsus ad sensum exanimes pulsantes tamen, reperrisse. Etmuller Differt. 2. cap. 10. fect. 5. This, as it is like what Ol, Lignus Lith, fo is a Confirmation of it, The Archbishop's Ala

BOOK VII. Migration of Birds. or any of those many intermediate Places over

which some of them probably fly.

And lastly, to all this, let us briefly add the Ac. commodations these Birds of Passage have, toenable them to take fuch long Flights, viz. the Length of their Wings, or their more than ordinary Strength (e) for Flight.

Account is, In Septentrionalibus aquis sapins casu Piscatoris extra huntur Hirundines, in modum conglomerate masse, que ore ad os & ala ad alam. & pede ad pedem post principium autumni sese inter car nas descensura colligarunt. — Massa autem illa per imperitos adole centes - extracta, atque in estuaria portata, caloris accessu Hirm dines resoluta, volare quidem incipiunt, sed exiguo tempore durant.

Mag. Hift. l. 19. c. 20.

Since my penning this Note, we had, at a Meeting of the Royal-Society, Feb. 12, 1713. a farther Confirmation of San lows retiring under Water in Winter, from Dr. Colas, a Person very curious in these Matters; who speaking of their Wave Fishing in the Northern Parts, by breaking Holes, and draw ing their Nets under the Ice, faith, That he faw fixteen Swi lows fo drawn out of the Lake of Samrodt, and about Thin out of the King's great Pond in Rosineilen; and that at Sill bitten, near an House of the Earl of Dohna, he saw two Swi lows just come out of the Waters, that could scarce stand, h ing very wet and weak, with their Wings hanging on the Ground: And that he hath observ'd the Swallows to be offer weak for some Days after their Appearance.

(e) As Swallows are well accommodated for long Flight by their long Wings, fo are Quails by the Strength of the pectoral Muscles, by the Breadth of their Wings, &c. h Quails have but short Wings for the Weight of their Bod and yet they fly from usinto warmer Parts against Winter, to us in Spring, croffing our Seas. So divers Travellerstell they cross the Mediterranean twice a Year, flying from Em to Africa, and back again: Thus Bellonius, in Mr. Willing faith, When we fail'd from Rhodes to Alexandria of Ægypt, my Quails flying from the North towards the South, were taken in Ship : whence I am verily perswaded, that they shift Places : For form ly also, when I sail'd out of the Isle of Zant to Morea, or Negropa in the Spring-Time, I had observ'd Quails stying the contrary Way, the South to North, that they might abide there all Summer. At which I also, there were a great many taken in our Ship. Ornith. p. 170.

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CHAP. IV. Of the Incubation of BIRDS.

A Nother Thing relating to the State of this Tribe of Animals, is their Incubation.

And first, the Egg it self deserves our Notice. Its Parts within, and its crusty Coat without, are adnirably well fitted for the Business of Incubation. That there should be one Part provided for the Fornation of the Body (a), before its Exit into the World, and another for its Nourishment, after it is ome into the World, till the Bird is able to shift or, and help it self; and that these Parts should be accurately brac'd, and kept in due Place (b), is ertainly a design'd, as well as curious Piece of Vorkmanship.

And

Aristotle saith, The long sharp Eggs brings Females; the round ones ith a larger Compass at the sharper End, Males. Hist. An. 1. 6. c. After which, he tells of a Sott at Syracuse, that sate Drinkg so long, till Eggs were hatch'd; as also the Custom of

Egypt, of hatching Eggs in Dunghills.

⁽a) The Chicken is form'd out of, and nourist'd by the White alone, lit be grown Great. The Yolk serves for the Chicken's Nouristment, ter it is well grown, and partly also after it is hatch'd. For a good art of the Yolk remains after Exclusion, being receiv'd into the Chicken's elly; and being there reserv'd, as in a Store-house, is by the [Apendicula, or Ductus Intestinalis,] as by a Funnel, convey'd into e Guts, and serves instead of Milk, &c. Willughby's Ornith. 1. c. 3. Ipsum animal ex also liquore Ovi corporatur. Cibus ejus in teo est. Plin. lib. 10. cap. 53.

⁽b) As the Shell and Skin keep the Yolk and two Whitestogether; so each of the Parts, (the Yolk and Inner Whitest least,) are separated by Membranes, involving them. At each End of the Egg is a Treddle, so call'd, because it was brimerly thought to be the Sperm of the Cock. But the Use these, (saith Dr. Harvey in Willugh, Ornith. c. 3.) is to be as

And then as to the Act it self, of Incubation, What a prodigious Instinct is it in all, or almost all the several Species of Birds, that they, and only they, of all Creatures, should betake themselves to this very Way of Generation? How should they be aware that their Eggs contain their Young, and that their Production is in their Power (c)? What should move them to betake themselves to their Nests, and there with Delight and Patience to abide the due Number of Days? And when their Young are gotten into the World, I have already shewn how admirable their Art, their Care, and zropp is in bringing them up until, and only until, they are able to shift for themselves.

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twere, the Poles of this Microcosm, and the Connections of all the Membranes twifted and knit together, by which the Liquors are not only conferv'd, each in its Place, but do also retain their due Position one to another. This, although in a great Measure true, yet doth not come up to what I have my felf observ'd; for I find, that these Chalaza, or Treddles, serve not barely to keep the Liquors in their Place, and Position to one another; but also to keep one and the fame Part of the Yolk uppermost, let the Egg be turn'd nearly which way it will; which is done by this Mechanism: The Chalaze are specifically lighter than the Whites, in which they fwim; and being brac'd to the Membrane of the Yolk, not exactly in the Axis of the Yolk, but somewhat out of it, causeth one Side of the Yolk to be heavier than the other; fo that the Yolk being by the Chalaza made buoyant, and kept swimming in the midst of two Whites, is by its own heavy Side kept with the same Side always uppermost; which uppermost Side, I have some Reason to think, is that on which the Cicatricula lies; that being commonly uppermost in the Shell, especially in iome Species of Eggs more, I think, than others.

(c) All Birds lay a certain Number of Eggs, or nearly that Number, and then betake themselves to their Incubation; but if their Eggs be withdrawn, they will lay more. Of

which, fee Mr. Ray's Wif. of God, p. 137.

(d) The

CHAP. IV. Incubation of Birds.

And lastly, when almost the Whole Tribe of Birds do thus, by Incubation, produce their Young, it is a wonderful Deviation, that some few Families only, should do it in a more novercal Way (d), without any Care or Trouble at all, only by laying their Eggs in the Sand, exposed to the Heat and Incubation of the Sun. Of this the Holy Scripture it felf gives us an Instance in the Oftrich: Of which we have an Hint, Lam. iv. 3. The Daughter of my People is become cruel, like the Offriches in the Wilderness. This is more plainly expressed in Fob xxxix. 14, 15, 16, 17. [The Oftrich] leaveth ber Eggs in the Earth, and warmeth them in the Duft, and forgetteth that the Foot may crush them, or that the wild Beast may break them. She is hardened against her Young ones, as though they were not hers: Her Labour is in vain, without Fear. Because GOD hath deprived her of Wisdom, neither hath He imparted unto ber Understanding. In which Words I shall take Notice of three Things: 1. Of this anomalous Way of Generation. It is not very strange, that no other Incubation but that of

⁽d) The Tabon is a Bird no bigger than a Chicken, but is faid to lay an Egg larger than a Goose's Egg, and bigger than the Bird it self. These they lay a Yard deep in the Sand, where they are hatch'd by the Warmth of the Sun; after which they creep out, and get to Sea for Provinons. Navarett's Account of China in Collect. of Voyages. Vol. 1. This Account is, in all Probability, borrow'd from Nievemberg, or Hernandez, (that copy'd from him,) who call this Bird by the Name of Daie, and its Eggs Tapun, not the Bird it self, as Navarette doth. But my Friend Mr. Ray saith of it, Historia is the proculdubio sabulosa & salsa est. Quamvis enim Aves nonnullo maxima ova pariunt, ut v. g. Alka, Lomwia, Anates, Arctica, &c. hu

Incubation of Birds. BOOK VII. the Sun, should produce their Young; but it is very odd and wonderful that any one Species should vary from all the rest of the Tribe. But above all, 2, The fingular Care of the Creator, in this Case, is very remarkable, in supplying some other Way the Want of the Parent-Animals Care and Eroppi (e) fo that the Young should, notwithstanding, be bred up in those large and barren Defarts of Arabia and Africa, and fuch like Places where those Birds dwell, the most unlikely and unfitting (in all Human Opinion) to afford Sustenance to young helpless Creatures; but the fittest therefore to give Demonstrations of the Wisdom, Care, and especial Providence of the Infinite Creator and Conservator of the World. 3. The last Thing I shall Remark is, That the Instincts of Irrational Animals, at least of this specify'd in the Text, is attributed to GOD. For the Reason the Text gives why the Ostrichis hardened against her Young Ones, as though they were not hers, is, Because GOD hath depriv'd her of Wisdom, and not imparted Understanding to her; i. c. He hath denied her that

jusmodi tamen unum duntaxat, non plura, ova ponunt antequam incubent: nec ullam in rerum natura avem dari existimo cujus ova albumim careant. Cum Albumen pracipua ovi pars sit, quodque primum fatu alimentum suhministrat. Raii Synop. Av. Meth. p. 155.

(e) The Eggs of the Ostrich being buried in the Sand, are cheribal only by the Heat of the Sun, till the Young be excluded. For the Writer of Natural History do generally agree, that the old Birds, after the have laid and covered their Eggs in the Sand, for sake them, and take m more Care of them. Willugh. Ornith. 1. 2. c. 8. fect. 1.

But there is another Ofirich [of America] which Acaret tells us of, that takes more Care of her Young, by carrying four of her Eggs, a little before the hatcheth, to four Parts of her Nest, there to breed Worms for Food for her Young. Acarets Difc. in Philos. Trans. No. 89. (f) See

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T upon of w deal parti riety Spec Arti ture more and ! Usef Fligh luch ces, and even who

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Wisdom, He hath not imparted that Understanding, that Exergi, that natural Instinct to provide for, and nurse up her Young, that most other Creatures of the same, and other Tribes, are endowed with.

Thus I have dispatch'd what I intended to infift upon concerning the State of this Set of Animals; of which, as also of their admirable Instincts, a great deal more might deserve our especial Observation; particularly the admirable Curiofity, Art, and Variety of Nidification (f), used among the various Species of Birds; the great Sagacity, and many Artifices used by them in the Investigation and Capture of their Prey (g), the due Proportion of the more and less useful, the Scarcety of the Voracious and Pernicious, and the Plenty of the Mansuete and Useful (b). Also the Variety of their Motion and Flight might deserve Consideration, the Swiftness of fuch whose Food is to be fought in far distant Places, and different Seasons (i); the slower Motion, and fhort Flights, of others more Domestick; and even the Aukwardness of some others to Flight, whose Food is near at Hand, and to be gotten without any great Occasion of Flight (k). These, and divers other fuch like Things as these, I say, I might have spoken more largely unto; but I shall pass them

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⁽f) See Book IV. Chap. 13.

⁽g) See Book IV. Chap. 11, and 14.

⁽b) See Book IV. the Beginning of Chap. 10.

⁽i) See Book IV. Chap. 8.

⁽k) The Colymbi, or Douckers, having their Food near at Hand in the Waters, are remarkably made for Diving therein. Their Heads are small, Bills sharp-pointed, Wings small, Legs slat and broad, and placed backward, and nearer the Tail than in other Birds; and lastly, their Feet; some are whole sooted, some cloven footed, but withal fin-toed. Vide Willings. Ornick. lib. 3. sett. 5.

362 The Conclusion. Book VII.

by with only a bare Mention, having already taken Notice of them in the Company of other Matters of the like Nature, and manifested them to be Acts of excellent Design, Wildom, and Providence, in the Great Creator.

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CHAP. V. The CONCLUSION.

A ND now, if we reflect upon the Whole Matter, we shall here find another large Tribe of the Creation, abundantly setting forth the Wisdom and Glory of their Great Creator. We praise the Ingenuity and Invention of Man, for the Contrivance of various pneumatick Engines; we think them witty, even for their unsuccessful Attempts to swimin, and fail through that fubtle Element the Air; and the curious Mechanism of that Artist is had in Remembrance, and praifed to this Day, who made a Dove, or an Eagle (a) to fly but a fhort Space. And is not therefore all imaginable Honour and Praise due to that Infinite Artist, that hath so admirably contrived and made all the noble Variety of Birds; that hath with fuch incomparable Curiofity and Art, formed their Bodies from Head to Tail, without and within, that not so much as any Muscle, or Bone, no, not even a Feather (b) is unartificially made, misplaced, redundant, or defective, in all the

(a) Vide Book V. Chap. 1. Note (aa).

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⁽b) Deus non solûm Angelum, & Hominem, sed nec exigui & contemptibilis animantis viscera, nec Avis pennulam, nec Herba flosculum, nec Arberis folium, sine suarum partium convenientia dereliquit. Augustin, de Civ. Dei, l. 5. c. 11.

feveral Families of this large Tribe? But every Thing is so incomparably performed, so nicely fitted up for Flight, as to surpass even the Imitation of the most ingenious Artificer among mortal rational Beings.

BOOK VIII.

Of INSECTS and REPTILES.

CHAP. I.

Of INSECTS in General.

AVING dispatch'd that Part of the Animal World, which used to be accounted the more perfect, those Animals stiled less perfect or imperfect, will next deserve a Place in our Survey, because when strictly enquired into, we shall find them to be so far from deserving to be accounted mean and despicable Parts of the Creation, owing their Original and Production to Putrefactions, &c. as some have thought, that we shall find them, I say, noble, and most admirable Works of GOD. For, as the samous Natural Historian, Pliny (a), prefaceth his Treatise of Insects, to prevent the Reproach of condescending

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⁽a) In magnis siquidem corporibus, &c. Plin. Nat. Hist. l. 11.

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(as might be thought) to so mean a Subject: In great Bodies, faith he, Nature had a large and easy Shop to work upon obsequious Matter; whereas, in these so small, and as it were no Bodies, what Footsteps of Reason, what Power, what great Perfection is there? Of this having given an Instance or two of the exquisite Senses, and curious Make of some Insects (b), he then goes on, We admire, faith he, the turrigerous Shoulders of Elephants, the lofty Necks and Crests of others; but, saith he, the Nature of Things is never more compleat than in the least Things. For which Reason he intreats his Readers (as I do mine) that because they slighted many of the Things themselves which he took Notice of, they would not therefore disdainfully condemn his Accounts of them, since, faith he, in the Contemplation of Nature, nothing ought to feem Superfluous.

Thus that eminent Naturalist hath made his own, and my Excuse too; the Force and Verity whereof will farther appear, by what I shall say of these Animals which (as despicable as they have

been,

⁽b) Ubi tot sensus conocavit in Culice? Et sunt alia dictu minori, Sed ubi Visum in eo pratendit: Ubi Gustatum applicavit? Ubi Odoratum inseruit? Ubi verò truculentam illam & portione maximam vocem ingeneravit? Quâ subtilitate Pennas adnexuit? pralongavit Pedum crura? Disposuit jejunam Caveam, uti Alvum? Avidam Sanguinis, & potissimum humani, sitim, accendit? Telum verò persodiendo tergul quo spiculavit ingenio? Atque ut in capaci, cum cerni non possit exilitas, ita reciproca geminavit arte, ut sodiendo acuminatum pariter sorbendoque sistuosum esset. Quos Teredini ad persoranda Robora cum sono teste dentes assixt? Potissimumque è ligno cibatum secit: Sed turvigeres Elephantorum miramur humeros, Taurorumque colla, & trucis in sublime jastus, Tigrium rapinas, Leonum jubas, cum rerum natura nusquam maeis quam in minimis, tota sit. Plin, ibid.

CHAP. II. The Shape of Insects.

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been, or perhaps may be thought) we shall find as exquisitely contrived, and curiously made for that Place and Station they bear in the World, as any other Part of the Animal World. For if we consider the innumerable Variety of their Species, the prodigious Numbers of Individuals, the Shape and Make of their little Bodies, and every Part thereof, their Motion, their Instincts, their regular Generation and Production; and, to name no more, the incomparable Beauty and Lustre of the Colours of many of them, what more admirable and more manifest Demonstration of the Insinite Creator, than even this little contemned Branch of the Animal World? But let us take a short View of Particulars.

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CHAP. II.

Of the Shape and Structure of Infects.

Let us begin with the Shape and Fabrick of their Bodies. Which although it be somewhat different from that of Birds, being particularly, for the most Part, not so sharp before, to cut and make way through the Air, yet is better adapted to their Manner of Life. For considering that there is little Necessity of long Flights, and that the Strength and Activity of their Wings doth much surpass the Resistance their Bodies meet with from the Air, there was no great Occasion their Bodies should be so sharpened before. But the Condition of their Food, and the Manner of gathering it, together with the great Necessity of accurate Vision, by that admira-

ble Provision made for them by the reticulated Cornea of their Eyes; these Things, I say, as they required a larger Room, so were a good Occasion for the Largeness of the Head, and its Amplitude before. But for the rest of their Body, all is well made, and nicely poised for their Flight, and every other of their Occasions.

And as their Shape, so the Fabrick and Make of their Bodies is no less accurate, admirable, and singular; not built throughout with Bones, and cover'd with Flesh and Skin, as in most other Animals; but cover'd with a curious Mail of a middle Nature (a), serving both as Skin and Bone too, for the Shape, as well as Strength and Guard, of the Body; and as it were on Purpose to shew, That the Great Contriver of Nature is not bound up to one Way only.

CHAP. III.

Of the Eyes and Antenna of Insects.

To this last-mention'd Guard, we may add, that farther Guard provided in the Eyes and Antenna. The Structure of the Eye, is, in all Creatures, an admirable Piece of Mechanism; but that observable in the Eyes of Insects so peculiar, that it must needs excite our Admiration: Fenced with its own Hardness, yea, even its own accurate Vision,

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⁽a) Insecta non videntur Nervos habere, nec Ossa, nec Spinas, nec Cartilaginom, nec Pinguia, nec Carnes, nec crustam quidem fragilem, ut quadam marina, nec qua jure dicatur Cutis: sed media cujusdam inter omnia hac natura corpus, &c. Plin. Nat. Hist. l. 11. c. 4.

CHAP. III. Eyes and Antennæ of Insects. 367

Vision, is a good Guard against external Injuries; and its Cornea, or outward Coat, all over beset with curious, transparent, lenticular (a) Inlets, enabling those Creatures to see, (no doubt,) very acturately every Way, without any Interval of Time or Trouble to move the Eye towards Objects.

And as for the other Part, the Antenna, or Feelers, whatever their Use may be in cleaning the Eyes, or other such like Use; they are, in all Probability, a good Guard to the Eyes and Head, in their Walk and Flight, enabling them, by the Sense of Feeling, to discover such Annoyances, which by their Proximity may perhaps escape

(a) The Cornea of Flies, Wasps, &c. are so Common an Intertainment with the Microscope, that every Body knows it is a curious Piece of Lattice-work. In which this is remarkable, that every Foramen is of a lenticular Nature; so that we see Objects through them topsey-turvey, as through to many convex Glasses: Yea, they become a small Telestope, when there is a due socal Distance between them and the Lens of the Microscope.

This lenticular Power of the Cornea, Supplies, (as I ima-ne,) the Place of the Crystalline, if not of the vitreous amour too, there being neither of those Humours that I ould ever find, (although for Truth fake, I confess I have of been fo diligent as I might in this Enquiry;) but instead Humours and Tunicks, I imagaine that every Lens of the mea, hath a distinct Branch of the Optic Nerve ministring to and rendring it as fo many distinct Eyes. So that as most Animals are binocular, Spiders for the most Part octonocular, I some, (as Mr. Willughby thought, Raii Hist. Insect. p. 12,) cocular; fo Flies, &c. are multocular, having as many Eyes there are Perforations in their Cornea. By which Means, other Creatures are oblig'd to turn their Eyes to Objects, lese have some or other of their Eyes ready plac'd towards Objects, nearly all round them: Thus particularly it is in the Dragon-Fly, (Libetta,) the greatest Part of whose Head is posses'd by its Eyes: Which is of excellent Use to that redatious Infect, for the ready seeing and darting at small Fles all round it, on which it preys.

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368 Eyes and Antennæ, &c. Book VIII, escape the Reach of the Eyes and Sight (b). Besides which, they are a curious Piece of Workmanship, and in May, a very beautiful Piece of (c) Garniture to the Body.

(b) It is manifest, that Insects clean their Eyes with their Fore-legs, as well as Antenna. And considering, that as they walk along, they are perpetually seeling, and searching be fore them, with their Feelers, or Antenna; therefore I am and to think, that besides wiping and cleaning the Eyes, the Usa Mere nam'd may be admitted. For as their Eyes are immoveable, so that no Time is requir'd for the turning their Eyes to Objects; so there is no Necessity of the Retina, at Optic Nerve being brought nigher unto, or set farther off from the Cornea, (which would require Time,) as it is in other Animals: But their Cornea and Optic Nerve, being always a one and the same Distance, are sitted only to see distantial Objects, but not such as are very nigh: Which Inconvenient the Feelers obviate, lest it should be prejudicial, in occasioning the Insect to run its Head against any Thing.

And that this, rather than the wiping the Eyes, is the chie Use of the Feelers, is farther manifest from the Antennal the Flesh Fly, and many other Insects, which are short, and strait, and incapable of being bent unto, or extended out the Eyes: As also from others enormously long, such those of the Capricorni, or Goat-chafers, the Cadew-Fly, and the

vers others, both Beetles and Flies.

(c) The lamellated Antenna of some, the clavellated of thers, the neatly articulated of others, the Feather'd and evers other Forms of others, of the Scarab, Papilionaum Gnat, and other Kinds; are surprizingly Beautiful, who view'd through a Microscope. And in some, those Anten distinguish the Sexes: As in the Gnat-kind, all those with Tusts, Feathers, and Brush-horns, are Males; those wishort, single shafted Antenna, are Females.



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CHAP. IV.

Of the Parts and Motions of Infects.

FROM the Head, pass we to the Members, concern'd in their Motion. And here we have a copious Subject, if I was minded to expatiate. I might take Notice of the admirable Mechanism in those that creep; the curious Oars in those amphibious Insects that swim and walk (a); the incomparable Provision made in the Feet of such as walk, or hang upon smooth Surfaces (b); the great Strength and Spring in the Legs of such

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(a) All the Families of Hydrocanthari, Notonetti, &c. have heir hindmost Legs made very nicely, with commodious loynts flat, and Bristles on each Side towards the End, serving for Oars to swim; and then, nearer the Body, are two tiff Spikes, to enable them to walk when Occasion is.

(b) I might here name divers Flies, and other Infects, who, esides their sharp hook'd Nails, have also skinny Palms to heir Feet, to enable them to flick on Glass, and other smooth Bodies, by Means of the Pressure of the Atmosphere. But ecause the Example will illustrate another Work of Nature, s well as this, I shall chuse a singular Piece of Mechanism, n one of the largest Sorts of Hydrocanthari. Of these large ones there are two Sorts, one largest, all black, with Antonna and somely emboss'd at the Ends. The other somewhat lefer, hardly to black, with capillary Antenna; the Forehead, Edges of the Vagina, and two Rings on the Thorax, of a awny Colour. The Female hath Vagina prettily furrow'd, he Male smooth. But that which is most to our Purpose in this Male, is a Flap, or hollowish Capnear the middle Joynt of the Fore-legs; which when clap'd on the Shoulders of the Female in Coits, sticks firmly thereon: After the Manner as 1 have feen Boys carry heavy Stones, with only a wet Piece of Leather clap'd on the Top of the Stone. (c) Thus

as leap (c); the strong and well-made Feet and Talons of such as dig (d): And to name no more, the admirable Faculty of such as cannot sly, to convey themselves with Speed and Safety, by the Help of their Webs (e), or some other Artistice to make their Bodies lighter than the Air (f): These

but

(i) Thus Grashoppers and Crickets have brawny strong Thighs, with long, slender, but strong Legs, which enable them to leap with great Agility and Strength.

(d) I have wonder'd to fee with what great Quickness, Art and Strength, many Vespa-Ichneumons, Wild-Bees, and Beetles, persorate the Earth; yea, even Wood it self: But the most remarkable Animal in this Way, is the Mole-Cricket.

in Book IV. Chap. 13. Note (s).

(e) I have with Pleasure often seen Spiders dart out their Webs, and fail away by the Help thereof. For the Manner of which, fee Mr. Lowth. Abridg. Vol. 2. p. 794. from Dr. Lifter and Dr. Hulfe, who both claim'd the Discovery thereof. And do both feem to have hit thereupon, without any Foreknowledge of what each other hath discover'd, asis faid in the last cited Place, and as I more particularly find by Mr. Ray's Philof. Letters, Printed Ann. 1718. p. 95, &c. By which also I find the two ingenious Doctors were very model in their Claims, and very amicable in the Matter. In one of Dr. Lister's to Mr. Ray, he thinks there is a fair Hint of the Darting of Spiders in Aristot. Hist. An. 1. 9. c. 39. And in Pliny, 1. 11. c. 24. But for their Sailing, that the Ancients are filent of, and he thinks it was feen first by him. And in another Letter, Fan. 20, 1670. speaking of the Height Spiders are able to fly, he faith, The last October, &c. I took Notice, that the Air was very full of Webs, I forthwith mounted to the Top of the highest Steeple on the Minster, [in York,] and could theme discern them yet exceeding high above me. Some that fell and wen intangled upon the Pinacles, I took, and found them to be Lupi; which Kind seldom or never enter Houses, and cannot be suppos'd to have taken their Flight from the Steeple.

Spiders, that have some Way of Conveyance, as little known to us, as that of Spiders formerly was. Thus the Squillula, pulices Arborescentes, and microscopical Animalcules of the stagnating Waters, so numerous in them, as to discolour sometimes the Water, and make them look as if they were tin-

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and a Multitude of other fich like Things as thefe, I might, I say, take Notice of, as great Evidences of the Infinite Creator's Wisdom: But lest I should be too tedious, I will confine my Observations to the Legs and Wings only. And these, at first View, we find to be incomparably fitted up for heir intended Service, not to over-load the Body, or in the least to retard it; but to give it the most roper and convenient Motion. What, for Example, an be better contriv'd, and made for this Service, han the Wings? Distended and strengthen'd by he finest Bones, and these cover'd with the finest and lightest Membranes, some of them adorn'd with

ed Red, Yellow or Green, or cover'd with a thick green cum; all which is nothing but Animalcules of that Colour. That these Creatures have some Way of Conveyance, I unclude; because most stagnating Waters are stock'd with em; new Pits and Ponds, yea, Holes and Gutters on the ops of Houses and Steeples. That they are not bred there aquivocal Generation, every ingenious, confidering Phisopher will grant; that they have not Legs for travelling far, is manifest from Inspection? And therefore I am apt to ink, that they have some Faculty of inflating their Bodies, darting out Webs, and making their Bodies buoyant, and ther than Air; or their Bodies, when dry, may be lighter an Air, and fo they can swim from Place to Place; or e Eggs of fuch as are oviparous, may be light enough to at in the Air. But then the Viviparous, (as my late ingeous Friend, Mr. Charles King, shew'd me the Pulices aquat. oref. are; these (I say,) can't be this Way accounted for. he Cause of these latter Suspicions was, that in the Summer onths, I have feen the Pulices arbores. and the green Scum on e Waters, (nothing but Animalcules, as I faid,) lie in a lanner dry on the Surface of the Waters; (at which Time, I have shewn in Book IV. Chap. 11. Note (n), I those Anialcules copulate; and perhaps, they may at the same Time ange their Quarters, and seek out new Habitations for their merous Offspring, as well as themselves. (g) It

with neat and beautiful Feathers (g); and many of them provided with the finest Articulations, and Foldings, for the Wings to be withdrawn, and neatly laid up in their Vagina, and Cases, and again readily extended for Flight (b).

And then for the Poising of the Body, and keeping it upright, and steady in Flight, it is an admirable Artifice and Provision for this Purpose; in some, by four Wings (i); and in such as have but two, by Pointels, and Poises plac'd under the Wings, on each side the Body.

And

(g) It is well known to all Perfons any way conversant in microscopical Observations, that these elegant Colours of Moths, and Buttersies, are owing to neat and well-made Feathers, set with great Curiosity and Exactness in Rows, and good Order.

(b) All that have Elytra, Scarabs (who have whole Elytra or reaching to the Podex, or the Hairward Jepos, such a Earwigs, and Staphilini of all Sorts, do, by a very curious Mechanism, extend and withdraw their membranaccous Wings, (wherewith they chiefly fly;) and it is very prest to see them prepare themselves for Flight, by thrusting our and unfolding their Wings; and again withdraw those Joyns and neatly fold in the Membranes, to be laid up safely in their Elytra or Cases. For which Service the Bones are well plac'd, and the Joynts ministring thereunto are accurately contrived, for the most compendious, and commodious solding up the Wings.

(i) For the keeping the Body steady and upright in Flight generally holds true, (if I mistake not,) that all bipenned and Insects have Poises joyn'd to the Body, under the hinder Part of their Wings; but such as have four Wings, or Wings with Elitra, none. If one of the Poises, or one of the Iester aux liary Wings be cut off, the Insect will fly as if one Side overbalanc'd the other, until it falleth on the Ground; so both be cut off, they will fly aukwardly, and unsteadily, ministering the Defect of some very necessary Part. These Poise or Pointells, are, for the most Part, little Balls, set at the To of a slender Stalk, which they can move every Way at Plesure. In some they stand alone, in others, (as in the who

Flest-Fly Tribe,) they have little Covers or Shields, und

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And lastly, It is an amazing Thing to reflect upon the surprizing Minuteness, Art, and Curiosity of the (k) Joynts, the Muscles, the Tendons, the Nerves, necessary to perform all the Motions of the Legs, the Wings, and every other Part. I have already mention'd this in the larger Animals; but to consider, that all these Things concur in minute Animals, even in the smallest Mite; yea, the Animalcules, that, (without good Microscopes,) escape our Sight; to consider, I say, that those minutest Animals have all the Joynts, Bones, Muscles, Tendons and Nerves, necessary to that brisk and swift Motion that many of them have, is so supposed to the superior of the same and the same and same all the same and same a

which they lie and move. The Use, no doubt, of these Poises, and secondary lesser Wings, is to poise the Body, and to obiate all the Vacillations thereof in Flight; serving to the nsect, as the long Pole, laden at the Ends with Lead, doth he Ropedancer.

(k) As all the Parts of Animals are mov'd by the Help of hele; so there is no doubt, but the minutest Animals have uch like Parts: But the Muscles and Tendons of some of he larger Insects, and some of the lesser too, may be seen

ith a Microscope.

(1) The minute Curiosities, and inimitable Fineries, obervable in those lesser Animals, in which our best Microscoes discover no Botch, no rude ill-made Work, (contrary to that is in all artistical Works of Man,) Do they not far more eserve our Admiration, than those celebrated Pieces of Iuman Art? Such as the Cup made of a Pepper-Corn, by swald Nerlinger, that held 1200 Ivory Cups, all gilt on the adges, and having each of them a Foot, and yet affording Room for 400 more, in the Ephem. Germ. T. 1. Addend. ad bs. 13. Such also was Phaeton in a Ring, which Galen thus essects upon, when he speaks of the Art and Wisdom of the saker of Animals, particularly such as are small, Quanto, with he, ipsum minus suerit, tanto majorem admirationem tibi excitabit; quod declarant Opisices cum in corporibus parvis aliquid insentant i sujus generis est quod nuper quidam in Annulo Phaejonta quant

BOOK VIII. Parts and Motions 374 manifesteth the Power and Wisdom of the Infinite Contriver of those inimitable Fineries. But having nam'd those minute Animals, Why should I mention only any one Part of their Bodies, when we have, in that little Compass, a whole and compleat Body, as exquisitely form'd, and, (as far as our Scrutiny can possibly reach,) as neatly adorn'd, as the largest Animal? Let us consider, that there we have Eyes, a Brain, a Mouth, a Stomach, Entrails, and every other Part of an Animal Body, as well as Legs and Feet; and that all those Parts have each of them their necessary Apparatus of Nerves, or various Muscles, and every other Part that other Infects have; and that all is cover'd and guarded with a well-made Tegument, befet with Briftles, adorn'd with neat Imbrications, and many other Fineries. And lastly, Let us consider in how little Compass all Art and Curiosity may lie, even in a Body many Times less than a small Grain of Sand (m); so that the least Drop of Water can contain

tuor equis investum sculpsit. Omnes enim equi franum, os, & denti anteriores habebant, &c. And then having taken Notice, that the Legs were no bigger than those of a Gnat, he shews that their Make did not come up to those of the Gnat; as also saith he, Major adhuc alia quadam esse videtur artis ejus, qui pulicem condidit, Vis atque Sapientia, quod, &c. Cum igitur Ars tanun tam abjectis animalibus appareat, — quantam ejus Vim ac Sapientiam in prassantioribus inesse putabimus? Galen. de Us. Part. l. 17. c. 1. fin.

(m) It will in some Measure appear, how wonderfully minute some microscopical Animalcules are, by what follows in the next Note. But because more particular Examples would be endless, I shall refer to the Observations of Mr. Lenwer-toeck, and others, in the Philos. Trans. and elsewhere.

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contain many of them, and afford them also sufficient Room to dance and frisk about in (n).

Having furvey'd as many of the Parts of Infects as I care to take Notice of ; I shall in the next Place fay somewhat of their State, and Circumstances of Life. And here I shall take Notice only of two Things, which have been only hinted at before : but will deserve more particular Consideration here, as being Acts of a wonderful Instinct; namely, Their Security of themselves against Winter; and their special Care of preserving their Species.

(n) It is almost impossible, by Reason of their perpetual Motion, and changing Places, to count the Number of the Animalcules, in only a Drop of the green Scum upon Water; but I guess I have sometimes seen not fewer than 100 frisking about in a Drop no bigger than a Pin's Head. But in fuch a Drop of Pepper-water, a far greater Number; these being much less than those.

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CHAP. V.

The Sagacity of Infects to secure themselves against Winter.

T is an extraordinary Act of Instinct and Sagacity, observable in the Generality of the Insect-Tribe, that they all take Care to secure themselves, and provide against the Necessities of Winter. That when the Distresses of Cold and Wet force them, hey should retire to warm and dry Places of Safety, is not strange; but it is a prodigious Act of he Infinite Conservator's Care, to enable some to ive in a different Kind of Infect-State; others to live,

B b 4

live, as without Action, so without Food; and others that act and eat, to lay up in Summer sufficient Provisions against the approaching Winter. Some, I say, live in a different State; for having sufficiently fed, nourished, and bred up themselves to the Perfection of their Vermicular, Nympha-State, in the Summer-Months, they then retire to Places of Safety, and there throw off their Nympha, and put on their Aurelia or Chrysalis-State for all the Winter, in which there are no Occasions for Food. This is the constant Method of many Families of the Insect-Tribe (a).

But there are others, and some of them in their most perfect State too, that are able to subsist in a kind of Torpitude, or Sleeping State, without any Food at all; by Reason as there is no Action, so no Waste of Body, no Expence of Spirits, and therefore no need of Food (b).

(b) I shall not name any of the particular Species of Infects which live in this State, because they are very numerous, but only remark two Things observable in their Sagacity in this Matter: 1. That they are not driven by Stress Weather to their Retirement, but seem as naturally to be

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⁽a) It would be endless to enter into Particulars here, because all the Papilionaceous, Flest, and Ichneumon-Fly Tribes, and all others that undergo the Nympha and Aurelia-State, between that of the Egg and Mature-State, (which are very numerous) appertain to this Note, For a Sample therefore only, I shall take what some may think a mean one, but if considered, deserves our Admiration, and that is the Sagicity of the White Butter-fly Caterpillar, which having sed it self its due Time, then retires to Places of Security. I have seen great Trains of them creeping up the Walls and Posts of the next Houses, where, with the Help of some Cobweblike Filaments, they hang themselves to the Cielings, and other commodious Places, and then become Aurelia; in which State and Places they hang secure from Wet and Cold, till the Spring, and warmer Months, when they are transmuted into Butter-slies.

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But for others that move and act, and need Food, it is a prodigious Instinct and Foresight the Creator hath imprinted on them, to lay up sufficient Food in Summer for the Winters (c) Necessities and Occasions. And it is very pretty to see with what unwearied Diligence all Hands are at work for that Purpose, all the warmer Months. Of this the Holy Scripture it self gives us an Instance in the Ant, calling that little Animal exceeding wife. Prov. xxx. 24. And the Reason is, ver. 25. The Ants are a People not strong, yet they

ake themselves thereto, as other Animals do to Rest and Sleep. For before the Approach of cold Weather, towards he End of Summer, we may see some Kinds of them slocking together, in great Numbers, within Doors (as Swallows do little before they leave us) as if they were making ready or their Winter's Rest. 2. That every Species betakes it elf to a proper convenient Receptacle; some under the Vaters to the Bottoms of Ponds; some under the Earth, elow the Frosts; some under Timber, Stone, &c. lying on he Ground; some into hollow Trees, or under the Bark, or n the Wood; some into warm and dry Places; and some into dry alone.

(c) There are not many Kinds that thus provide their food before-hand. The most remarkable, are the Ant and he Bee; concerning the first of which, Origen hath this Renark, viz: De solertid Formicarum, ventura byemi mature prospicitium, sibique invicem sub onere sessis succurrentium; quòdque fruges rosas condunt, ne rursus enascantur, sed per annum alimento sint, non sticcinationem Formicarum in causa debemus credere, sed almam matem Naturam bruta quoque sic ornantem, ut etiam minimis addat a quadam ingenia. Orig. cont. Cels. L. 4.

But as for Wasps, Hornets, Humble-bees, and other Wild-bees, espa Ichneumons, and divers others that carry in Materials for Nests and Food; this is only for the Service of their Generation, for hatching their Eggs, and nourishing their Young, ot for Supplies in Winter; for they all forsake their Nests towards Winter, and retire to other Quarters, living (I conceive) without Food all that Time.

(d) Hos

they prepare their Meat in the Summer. And therefore Solomon sends the Sluggard to this little contemptible Creature, to learn Wisdom, Fore. sight, Care and Diligence. Prov. vi. 6, 7, 8. Go to the Ant, thou Sluggard, consider her Ways, and he wise: which having no Guide, Overfeer, or Ruler, provideth her Meat in the Summer, and gathereth her Food in the Harvest.

To this Scriptural Example, give me leave to anticipate, and subjoin an Observation of the farther great Wisdom of this little Creature; and that is their unparallelled zroppin, their Tenderness, Sagacity, and Diligence about their Young (d). Tis very diverting, as well as admirable to see

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Sir Edward King, who was very curious in examining the Generation of Ants, observes their great Care and Diligence 1. About their Sperm, or true Eggs, which is a fine white Substance, like Sugar, which they diligently gather togethe into a Heap, when scattered; and on which they lie in Multitudes, (I suppose, by way of Incubation.) 2. I have observed.

⁽d) Hos vermiculos [Formicarum Ova vulgo vocatos] incredibili soey & cura Formica educant, summamque dant operam, " vel tantillum, quod spectet eorum vermiculerum educationem atque in tritionem, omittant: quem in finem fere semper eosdem ore circumptant secum, ne ulla eos ladet injuria. In museo meo nonnullas istius se neris formicas, vitro terra repleto, conclusas cum Vermiculis istis adu vabam: ibi non fine jucunditate spectabam, quo terra fieret in superfin ficcior, eo profundius Formicas cum fætibus suis prorepere: cum un aquam adfunderem, visu mirificum erat, quanto affectu, quanta fil eitudine, quanta Stopy omnem in eo collocarent operam, ut faiu suos sectiore & tuto loco reponerent. Sapius vidi, cum aliquot dien aqua caruissent, atque cum affuso tantillo aqua terram illam bunto barem, è vestigio à Formicis fœtus suos eo loci fuisse allates, questi distincte conspiciebam moveri atque sugere humorem. Multoties conatus, ut cos Vermicules ipse educarem, at semper conatum fefellite ventus: neque ipsas Formicarum Nymphas alimenti jam non indiga unquam sine ipsis Formicis potui fotu artificiali excludere. T. Swam merd. Epilog. ad Hist. Infect. pag. 153.

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with what Affection and Care they carry about their Young in their Mouths, how they expose themselves to the greatest Dangers, rather than leave their Young exposed or forfaken; how they remove them from Place to Place in their little Hills, sometimes to this Part, sometimes to that, for the Benefit of convenient Warmth, and proper Moisture; and then again withdraw, and guard them against Rain and Cold. Now that this great Wisdom which the Scriptures attribute unto, and is discernible in this little Animal, is owing only to he Instinct, or Insusions of the Great Conservaor of the World, is evident, because either this Wildom, Thought, and Forecast, is an Act of the Animal it felf, or of some other Being that hath Wisdom. But the Animal being Irrational, 'tis imoffible it can be its own Act, but must be derivd, or received from some Wise Being. And who? What can that be, but the Infinite Lord, Conferator and Governor of all the World?

CHAP. VI.

Of the Care of Infects about their Young.

THE other notable Instinct I am to treat of, is the peculiar Art and Care of the Infect-Tribe, about

I, faith he, in Summer, that in the Morning they bring up ofe of their Young (call'd Ant-Eggs) towards the Top of e Bank: So that you may from 10 in the Morning, until or 6 in the Afternoon, find them near the Top-for the oft Part on the South-side the Bank. But towards 7 or 8 Night, if it be cool, or likely to rain, you may dig a Foot eep before you can find them. Philof. Trans. No. 23. or Mr. owthorp's Abridg. V. 2. p. 7, and 9.

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about the Preservation of their Species. Here I might speak of many Things, but I have occasionally mentioned divers of them before, under some or other of the General Heads, and therefore shall fix only upon two Things relating to their Special Art and Care about the Production (a) of their Young, which have not been so particu-

larly spoken to as they deserve.

One Thing is their singular Providence for their Young, in making or finding out such proper Receptacles and Places for their Eggs and Seed, as that they may receive the Advantage of a sufficient Incubation, and that the Young, when produced, may have the Benefit of proper and sufficient Food for their Nurture and Education, till they are able to shift for themselves. It is admirable to see with what Diligence and Care the several Species of Insects lay up their Eggs, or Sperm, in their several proper Places; not all in the Waters, in Wood, or on Vegetables; but those whose Subsistence is in the Waters (b), in the Water;

(a) The Doctrine of Aquivocal Generation, is at this Day fo sufficiently exploded by all learned Philosophers, that I shall not enter the Dispute, but take it for granted, that all Animals spring from other Parent-Animals. If the Reader hath any Doubt about it. I refer him to Saigneur Redi de Gan, Insect. and Mr. Ray's Wisdom of God, &c. p. 344. See also be fore, Book IV. Chap. 15. Note (a).

⁽b) It would be Endless to specifie the various Species of Insects, that have their Generation in the Waters. And therefore I shall only observe of them, 1. That their Egg are always laid up with great Care, and in good Order. And also, 2. Where proper and sufficient Food is. 3. That in their Nympha-State in the Waters, they have Parts proper for Food and Motion; and in many, or most of them, very different from what they have in their Mature-State, a manifest of the state of the s

CHAP. VI. Insects Care of their Toung. 381 those to whom Flesh is a proper Food, in Flesh (c); those

nifest Argument of the Creator's Wisdom and Providence.

For an Instance, see Note (r).

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(e) As Seigneur Redi was one of the first that made it his Business to discard Anomalous Generation, so he tried more Experiments relating to the Vermination of Serpents, Flesh, Fish, putrified Vegetables; and in short, whatever was commonly known to be the Nursery of Maggots, more, I say, probably, than any one hath done fince. And in all his Observations, he constantly found the Maggots to turn to Aurelia, and these into Flies. But then, saith he, Dubit are copi, utrum omne hoc vermium in carne genus, ex solo Muscarum semine, an ex ipis putrefactis carnibus oriretur, tantoque magis confirmabar in hoc meo lubio, quanto in omnibus generationibut _______fapiùs videram, in carnius, antequam verminare inciperent, resedisse ejusdem speciei Muscas, ujus propago postea nascebatur. Upon this he tells us, he put Fish, Flesh, &c. into Pots, which he covered close from the Flies with Paper, and afterwards (for the free Air-fake) with Lawn, whilst other Pots were left open, with fuch like Flesh, &c. in them; that the Flies were very eager to get nto the covered Pots; and that they produced not one Maggot, when the open ones had many. Fr. Redi de Gener. nsect.

Among the Infects that come from the Maggots he menions, he names Culices. Now from the most critical Observations I have made, I never observed any Sort of Gnat to ome from putrified Flesh, Vegetables, or any other Thing he taxeth them with. So that either he means by Culex, ome Fly that we call not by the Name of Gnat; or else their Gnats in Italy, vary in their Generation from ours in England. For among above thirty, near forty, distinct Species of Gnats hat I have observed about the Place where I live, I never bund any to lay their Eggs in Flesh, Fish, &c. but the largest Sort, called by Aldrovand, Culices maximi; by Swammerdam, Tipula terrestres, lay their Eggs in Meadows, &c. under the Grass; one of the larger middle Sort, in dead Beer, Yeast, &c. lying on the Tops, or in the Leaks of Beer-Barrels, &c. and all the rest (assar as ever I have observed) lay and hatch

n the Waters, as in Note (r).

The Generation of the Second of these being akin to some of the foregoing Instances, and a little out of the Way, may be lest a Place here. This Gnat lays its Eggs commonly in lead Beer, &c. as I said, and probably in Vinegar, and other lich Liquors. Some Time after which, the Maggots are so

382 Infects Care of their Toung. BOOK VIII. those to whom the Fruits (d) or Leaves of Vegetables

numerous, that the whole Liquor stirreth as if it was alive; being sull of Maggots, some larger, some smaller; the larger are the Off-spring of our Gnat, the smaller, of a small dark coloured Fly, tending to reddish; frequent in Cellars, and such obscure Places. All these Maggots turn to Aurelia, the larger of which, of a Tan-Colour, turn to our Gnat. This Gnat is of the unarmed Kind, having no Spear in its Mouth, Its Head is larger than of the common Gnats, a longer Neck, short-jointed Antenna, spotted Wings, reaching beyond its slender Alvus; it is throughout of a brown Colour, tending to red, especially in the Female: The chief Difference between the Male and Female, is (as in other Gnats, yea, most Insects) the Male is less than the Female, and hath a slenderer Belly, and its Podex not so sharp as the Female's is.

(d) The Infects that infest Fruits, are either of the lohnenmon-Fly Kind, or Phalana. Plumbs, Pease, Nuts, &c. produce fome or other Ichneumon-Fly. That generated in the Plumbis black, of a middle Size, its Body near three tenths of an Inch long, its Tail not much less, consisting of three Bristles, wherewith it conveys its Eggs into Fruits: Its Antenna, or Horns, long, slender, recurved; its Belly longish, tapering, small towards the Thorax; Legs reddish; Wings membranaceous, thin and transparent, in Number 4, which is one Charac-

teristick of the Ichneumon-Fly.

The Peafe Ichneumen-Fly, is very fmall, Wings large, reaching beyond the Podex; Antenne long; Alvus short, shaped like an Heart, with the Point towards the Anus; it walked and flieth slowly. No Tail appears as in the former; but they have one lieth hidden under the Belly, which they can at Pleasure bend back to pierce Pease when they are young and tender, and other Things also, as I have Reason to suppect, having met with this (as indeed the former two) in

divers Vegetables.

Pears and Apples I could never discover any Thing to breed in, but only the lesser Phalana, about four-tenths of an Inch long, whitish underneath; greyish-brown above (dappled with brown Spots, inclining to a dirty Red) all but about a third Part at the End of the Wings, which is not grey, but brown, elegantly striped with wavey Lines, of a Gold Colour, as if gilt; its Head is small, with a Tust of whitish-brown in the Forehead; Antenna smooth, moderately long. The Aurelia of this Moth is small, of a yellowish Brown. I know not what Time they require for their Generation out of Boxes;

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CHAP. VI. Infects Care of their Young. 383 ables are Food, are accordingly reposited, some in his Fruit, some on this Tree (e), some on that Plant (f), some on another, and another; but confantly the same Family on the same Tree or Plant, he most agreeable to that Family. And as for ohers that require a constant and greater Degree f Warmth, they are accordingly provided y the Parent Animal with some Place in or bout the Body of other Animals; some in the eathers of Birds (g); some in the Hair of Beafts

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it those I laid up in August, did not become Moths before une following.

(e) There are many of the Phalana, and Ichneumon-Fly ribes, that have their Generation on the Leaves, or other rts of Trees and Shrubs, too many to be here reckoned up. he Oak hath many very beautiful Phalane, bred in its conwived Leaves, white, green, yellow, brown spotted prettily, and neatly dappled, and many more befides; and its Buds ord a Place for Cases, and Balls of various Sorts, as shall shewn hereafter; its Leaves expanded, minister to the ermination of globular, and other sphæroidal Balls, and Theca, some like Hats, some like Buttons excavated in Middle; and divers others fuch like Repositories, all onging to the Ichneumon-Fly Kind. And not only the Oak. the Maple also, the White-Thorn, the Briar, Privet, and ind almost every Tree and Shrub.

f) And as Trees and Shrubs, so Plants have their pecu-Infects. The White-Butterfly lays its voracious Offing on Cabbage-Leaves; a very beautiful reddish oceld one, its no less voracious black Off-spring of an horrid pect, on the Leaves of Nettles; as also doth a very beautismall, greenish Ichneumon-Fly, in Cases on the Leaves of fame Plant: And to name no more (because it would be less) the beautiful Ragwort-Moth, whose upper Wings are wn, elegantly spotted with red, and under Wings edged h brown; these, I say, provide for their golden ring'd ce upon the Ragwort-Plant.

s) Many, if not most Sorts of Birds, are infested with a inct Kind of Lice, very different from one another in oxes; pe, Size, &c. For Figures and Descriptions of them, I

384 Infects Care of their Young. BOOK VIII Beasts (b); some in the very Scales of Fishes (i); some in the Nose (k); some in the Flesh

Shall refer to Signieur Redi of Insects. See also Moufet, 1. 2. 4 23. These Lice lay their Nits among the Feathers of the respective Birds, where they are hatched and nourished; and as Aristotle saith, would destroy the Birds, particularly Phasants, if they did not dust their Feathers. Loco infr. citat.

(b) And as Birds, fo the feveral Sorts of Beafts have their peculiar Sorte of Lice; all distinct from the two Sorts infell ing Man: Only the Ass, they say, is free, because our Satism rode upon one, as some think; but I presume it is rather from the Passage in Pliny, 1. 11. c. 33. or rather Arist. His Animal. 1. 3. 6. 31. who faith, Quibus pilus eft, non carent coun [Pediculo] excepto Asino, qui non Pediculo tantum, verum etiam Ro divio immunis est. And a little before, speaking of those in Ma he shews what Constitutions are most subject to them, and instanceth in Aleman the Poet, and Pherecydes Syrius that did of the Pthiriafis, or Lowfy Difease. For which foul Distemper if Medicines are defired, Moufet de Insect. p. 262. may be confulted. Who in the same Page hath this Observation, A madverterunt nostrates ubi Asores insulas à tergo reliquerint, Pe diculos confestim omnes tabescere: atque ubi eas reviserint, iterumi numeros alies subitò oriri. Which Observation is confirmed b Dr. Stubs. Vid. Lowth. Abridg. V. 3. p. 5.58. And many Seams have told me the fame.

(i) Fishes, one would think, should be free from Lice, reason they live in the Waters, and are perpetually movin in, and brushing through them; but yet they have their Som

too.

Befides which, I have frequently found great Numbers long flender Worms in the Stomachs, and other Parts of Fl particularly Codfife, especially such as are poor; which Wom have work'd themselves deeply into the Coats and Flesh, that they could not eafily be gotten out: So Aristotle saith some Fishes, Battero & Tittoni Lumbricus innascitur, qui debilit &c. Chalcis vitio infestatur diro, ut Pediculi sub Branchiis in quam multi interimant. Hift. An. L. 8. c. 20.

(k) Of Infects bred in the Nose of Animals, those int Noffrils of Sheep are remarkable. I have my felf taken not fewer at a Time than twenty or thirty rough Maggo lying among the Lamina of the Nostrils. But I could not hatch any of them, and so know not what Animal they ceed from: But I have no great doubt, they are of the

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CHAP. VI. Infects Care of their Young. 385 (); yea, some in the very Bowels (m); and in-

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umon-Fly Kind; and not improbably of that with a long ail, call'd Trifera, whose three Bristles seem very commoous for conveying its Eggs into deep Places. I have also seen a rough whitish Maggot, above two Inches

thin the Intestinum rectum of Horses, firmly adhering therethat the hard Dung did not rub off. I never could bring em to Perfection, but suspect the Side-Fly proceeds from

(1) In the Backs of Cows, in the Summer-Months, there are aggots generated, which in Effer we call Wornils; which are t only a small Knot in the Skin; and I suppose no other in an Egg laid there by fome Infect. By Degrees these nots grow bigger, and contain in them a Maggot lying in a rulent Matter: They grow to be as large as the End of 's Finger, and may be squeez'd out at a Hole they have ays open: They are round and rough, and of a dirty White. th my utmost Endeavour and Vigilance, I could never difer the Animal they turn into; but as they are somewhat e, fo may be the same as those in the Note before. In Persia there are very long slender Worms, bred in the gs, and other Parts of Men's Bodies, 6 or 7 Yards long. n Philos. Trans. Mr. Dent, and Mr. Leavis, relate divers Exples of Worms taken out of the Tongue, Gums, Nose, and

er Parts, by a Woman at Leicester, which they were Eyenesses of. These, and divers others mention'd in the nsations, may be seen together in Mr. Lowthorp's Abridg. 3. p. 132.

Varrat mihi vir fide dignus ___ Casp. Wendlandt ___ se in Po-, puero cuidam rustico duorum annorum, Vermiculum album ê ebrâ extraxisse, —magnitudinis Eruca. —Sumilem sero buic m mihi [Schulzio] & D. Segero narravit boc. Anno 1676. chius noster Anat. Statlender, qui chidam puero, ex Aure, extranit miculum talem, qualis in nucibus avellanis perforatis latitare solet paulo majorem, coloris albissimi; alteri minores 5 ejus dem generis liter ex Aure: Omnes aliquot horas supervixerunt --- Vermiculos uc viventes oculis nostres vidimus. Ephem. Germ. T. 2. Obs. ubi Vermiculi Icon. Many other Inflances may be met h in the same Tome. Obs. 147, 148, 154.

The Worms in Deer are mention'd often among Ancient iters. Ariftotle faith, ZROANKAS METTOL TAVTES EXBOLY, OF TH ahi Courass &c. They [Deer] all have live Worms in sheir ds 3 bred under the Tongue, in a Cavity near the Vettebra; on

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which the Head is plac'd; their Size not less than of the largest Mag gots; they are bred all together, in number about twenty. Aristo

Hift. Animal. 1. 2. c. 15.

To these Examples may be added the Generation of the Ichneumon-Fly in the Bodies of Caterpillars, and other Nymbol of Insects. In many of which, that I have laid up to hatch'd in Boxes, instead of Papilios, &c. as I expected have found a great Number of small Ichneumon-Flies, which Parent-Animal had wounded those Nymphe, and darted in Eggs into them, and so made them the Foster Mother of its Young. More Particulars of this Way of Generation may be seen in the great Mr. Willugbby's Observations in Pin Trans. No. 76. But concerning the farther Generation of the Insect, I have taken Notice of other Particulars in other Paces of these Notes.

(m) The Animals ordinarily bred in the Stomach as Guts, are the three Sorts of Worms call'd Lati Teretes, at Ascarides; concerning which, it would be irksome to spel in Particular, and therefore I shall refer to Mouset, 1, 2, 2, 32, 33. Dr. Tyson's Anatomy of them in Mr. Lowthory's bridg. V. 3, p. 121. Seigneur Redi's Obs. and others that he

written of them.

And not only Worms, but other Creatures also are faile be found in the Stomach; Instances of which are so insum rable, that I shall only select a sew related by Persons of the best Credit. And first of all, by some of our own Count men. Dr. Lister, (whose Credit and Judgment will have be question'd,) gives an Account of true Caterpillars, vomit up by a Boy of nine Years old; and another odd Animali a poor Man. Mr. Fessop, (another very judicious, cum and ingenious Gentleman) saw Hexapods vomited up by Girl; which Hexapods liv'd and sed for sive Weeks.

Lowth. ib. p. 135.

And to Foreigners, it is a very strange Story, (but attell by Persons of great Repute,) of Catharina Geileria, that din Feb. 1662. in the Hospital of Altenburg, in Germany, we for twenty Years voided by Yomit and Stool, Toads a Lizzards, &c. Ephemer. Germ. T. 1. Obs. 103. See also to 9th Observation of a Kitten bred in the Stomach, and mitted up; of Whelps also, and other Animals, bred in Manner. But I fear a Stretch of Fancy might help in so of those last Instances, in those Days when spontaneous meration was held, when the Philosophers seem to have me slightly examined such Appearances than now they do. I for the breeding of Frogs or Toads, or Lacerta Aquatica in Stomach, when their Spawn happeneth to be drank, the

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i fui rêqu CHAP. VI. Infects Care of their Young. 387 most Recesses of the Bodies of Man and other Creatures (n): And as for others to whom none of these

a Story in the second Tome of the Ephem. Germ. Obs. 56. hat favours it, viz. In the Year 1667, a Butcher's Man going to sy some Lambs in the Spring, being thirsty, drank greedily of some anding Water, which a while after, caus'd great Pains in his Stomach, bich grew worse and worse, and ended in dangerous Symptoms. At see thought somewhat was alive in his Stomach, and after that, mited up three live Toads; and so recover'd his sormer Health.

Such another Story Dr. Sorbait tells, and avoucheth it en with his own Eyes, of one that had a Toad came t of an Abscess, which came upon drinking foul Water.

J. 103.

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(n) Not only in the Guts, and in the Flesh; but in many her Parts of the Body, Worms have been discover'd. One is voided by Urine, by Mr. Mat. Milford, suppos'd to have me from the Kidneys. Lowth, ib. p. 135. More fuch Exples Moufet tells of. Ibid. So the Vermes Cucurbitini are very mmon in the Vessels in Sheeps Livers: And Dr. Lister Ils of them, found in the Kidney of a Dog, and thinks that e Snakes and Toads, &c. faid to be found in Animals Boes, may be nothing effe. Lowth, ib. p. 120. Nay, more an all this: In Dr. Bern. Verzascha's fixth Observation, ere are divers Inflances of Worms bred in the Brain of an. One, a Patient of his, troubled with a violent Headh, and an Itching about the Nostrils, and frequent Sneez-; who, with the Use of a Sneezing-Powder, voided a orm, with a great deal of Snot from his Nofe. A like tance he gives from Bartheline, of a Worm voided from tho ofe of O. W. which he guesseth was the famous Olaus Woru: Another, from a Country-Woman of Dietmarfo; and ers in Tulpius, E. Hildanus, Schenckius, &c. Thefe Worms thinks are undoubtedly bred in the Brain: But what way y can come from thence, I can't tell. Wherefore I ra-, and even that Worm that was actually found in the Brain the Paris Girl (when opened) I guess might be laid in Lumina of the Nostrils, by some of the Ichneumon, or other ect-Kind, and might gnaw its way into the Brain, through Os cribiforme. Of this he tells us from Bartholine, Tandem tabida obiisset, statim aperto cranio presentes Medici totam ceresubstantiam, que ad dexterum vergit, à reliquo corpore sejunctam; raque tunica involutam deprehenderunt : kac tunica rupta latentem Vermons

these Methods are proper, but make themselves Nests by Perforations in the Earth, in Wood, or Combs they build, or such like Ways; 'tis admirable to see with what Labour and Care they carry in, and seal up Provisions, that serve both for the Production of their Young, as also for their Food and Nurture when produced (0).

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The other Piece of remarkable Art and Can about the Production of their Young, is their Can riolity and Neatness in repositing their Eggs, and

in their Nidification.

As to the first of which, we may observe, that great Curiosity and nice Order is generally observed by them in this Matter. You shall always see their Eggs laid carefully and commodiously up (p). When upon the Leaves of Vegetables or other Material on Land, always glu'd thereon with Care, with one certain End lowermost, and

Vermem vivum, & pilosum, duobus punëtis splendidis loco oculorum p didit, ejusdem sere molis cum reliqua Cerebri portione, qui duarumb varum spacio supervixit. B. Verzas. Obs. Medicæ, p. 16.

Hildanus tells us fuch another Story, viz. Filius Theod, a der Roulen, Avunculi mei, diuturno vexabatur dolore capitis.—Dei febricula & sternutatione exorta, ruptus est Abscessus circa os cribina — & Vermis prorepsit. By his Figure of it, the Mago was an Inch long, and full of Bristles. Fabri Hildan. Cent.

Galenus Wierus (Physician to the Princ. Jul. & Cleve) faith, told him, that he had, at divers Times, found Wom in the Gall-bladder in Persons he had opened at Dusseldors. ib. Obs. 60.

(o) See before, Book IV. Chap. 13. Note (c).

⁽p) Some Infects lay up their Eggs in Clusters, as in Hold of Flesh, and such Places, where it is necessary they show be crouded together; which, no question, prevents the being too much dried up in dry Places, and promotes the hatching. But,

fome round Holes, their Feet as well made to cratch and bore (t), and their Body handsomely urned and fitted to follow. But for such as build or spin themselves Nests, their Art justly bids Desiance to the most ingenious Artist among Men, o much as tolerably to copy the nice Geometrical Combs of some (u), the Earthen Cells of others, or the Webs, Nets and Cases (w) woven by ohers. And here that natural Glue (x) which their

(t) Thus the Mouths and other Parts of the Ichneumon-Tafos in Book IV. Chap. 13. Note (c). So the Feet of the ryllotalpa, ibid. Note (s).

(a) See the last cited Places, Note (o).

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(w) Of the textrine Art of the Spider, and its Parts serving

that Purpose, see the last cited Place, Note (x). Besides these, Caterpillars, and divers other Insects, can emit

hreds, or Webs for their Use. In this their Nympha-State, they secure themselves from falling, and let themselves down om the Boughs of Trees, and other high Places, with one these Threads. And in the Cases they weave, they secure

emselves in their Aurelia-State.

And not only the Off-spring of the Phalana-Tribe, but there e some of the Ichneumon-Fly Kind also, endowed with this strine Art. Of these I have met with two Sorts; one that un a Milk-white, long, round, filken Web, as big as the top ones Finger, not hollow within, as many are, but filled roughout with Silk. These are woven round Bents, Stalks Ribwort, &c. in Meadows. The other is a lump of many llow, filken Cases, sticking confusedly together on Posts, der Cole-worts, &c. These Webs contain in them, small, hitish Maggots; which turn to a small, black Ichnoumon-Fly, th long, capillary Antenna; Tan-coloured Legs; long Wings aching beyond their Body, with a black Spot near the iddle; the Alvus like an Heart; and in some, a small seteous Tail. Some of these Flies were of a shining, beautigreen Colour. I could not perceive any Difference, at aft, not specifical, between the Flies coming from those two oductions.

(x) I have often admired how Wasps, Hornets, Ichneumonssps, and other Insects that gather dry Materials for buildtheir Nests, have found a proper Matter to cement and

their Bodies afford some of them to consolidate their Work, and combine its Materials together, and which in others can be darted out at Pleasure, and spun and woven by them into silken Balls (y) or Webs. I say, this so peculiar, so service able a Material, together with the curious Structure of all Parts ministring to this textrine Power, as mean a Business as it may seem, is such as may justly be accounted among the noble Designs and Works of the Infinite Creator and Conservator of the World.

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In the last Place, there is another prodigious Faculty, Art, Cunning, or what shall I call it? that others of those little Animals have, to make even Nature it self serviceable to their Purpose; and that is the making the Vegetation and Growth of Trees and Plants, the very Means of the building of their little Nests and Cells (2), such as an

glue their Combs, and line their Cells; which we find a ways sufficiently context and firm. But in all Probability, this useful Material is in their own Bodies; as 'tis in the Tinea vestivora, the Cadew-Worm, and divers others. Goeld observes of his Eruca, Num. xx. 6. that fed upon Swallow Leaves, that it made its Cell of the comminuted Leaves, glud together with its own Spittle, her pulveris aut arena instance minuit, ac pituitoso quodam sui corporis succo ita maceravit, ut in accommodatum subeunda mutationi instanti locum sibi exstruxerit. In muncula hac à communi Salieum ligno nihil differre videbatur, in quòd longè esset durior, adeò ut cultro vix disrumpi posset.

(y) An ingenious Gentlewoman of my Acquaintance, Wife to learned Physician, taking much Pleasure to keep Silk-Worms, had me the Curiosity to draw out one of the oval Cases, which the Silk-Worms, into all the Silken Wire it was made up of, which, to it great Wonder as well of her Husband, as her self, —appeared to be measure, a great deal above 300 Yards, and yet weighed but its Grains and an half. Boyle Subtil. of Etfluv. ch. 2.

(2) Since my penning this, I have met with the most spacious Malpighi's Account of Galls, &c. and find his Descrip

CHAP. VI. Nidification of Injects. 389

with handsome juxta-Positions (q). Or if in the Waters, in neat and beautiful Rows oftentimes, in that spermatick, gelatine Matter, in which they are reposited, and that Matter carefully ty'd and fastned in the Water, to prevent its Diffipation (r), and weaving themielves Cales and I

(q) As for such as are not to be clustered up, great Order is used. I have seen upon the Posts and Sides of Windows, little round Eggs, refembling small Pearl, which produced small hairy Caterpillars, that were very neatly and orderly, laid. And to name no more, the White Butterfly lays its neat Eggs on the Cabbage Leaves in good Order, always gluing one certain End of the Egg to the Leaf. I call them neat Eggs, because if we view them in a Microscope, we shall and them very curiously furrowed, and handsomely made and adorned.

(r) By Reason it would be endless to specify the various Generation of Infects in the Water, I shall therefore (because t is little observed) take Pliny's Instance of the Gnat, a mean and contemned Animal, but a notable Instance of Nature's

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The first Thing confiderable in the Generation of this infect is (for the Size of the Animal) its vast Spown, being some of them above an Inch long, and half a quarter Diameter; made to float in the Waters, and tied to some Stick, Stone, or other fix'd Thing in the Waters, by a fmall Stem, or Stalk. In this gelatine, transparent Spawn, the Eggs are heatly laid; in fome Spawns in a fingle, in some in a double spiral Line, running round from end to end, as in Fig. 9, and

10; and in some transverily, as Fig. 8.

When the Eggs are by the Heat of the Sun, and Warmth of the Season hatched into small Maggots, these Maggots descend to the bottom, and by means of some of the gelatine Matter of the Spawn (which they take along with them) they stick to Stones, and other Bodies at the bottom, and there make themselves little Cases or Cells, which they creep into and out of at Pleasure, until they are arrived to a more mature Nympha-State, and can swim about here and there, to seek for what Food they have occasion; at which Time, they are a kind of Red-worms, above half an Inch long, as in

Thus far this mean Infect is a good Instance of the Divine Providence towards it. But if we farther confider, and com-Cc3

390 Nidification of Infects. Book VIII. or if made to float, fo carefully spread and poiled. as to fwim about with all possible Artifice.

And as to their other Faculty, that of Nidification, whether it be exerted by boring the Earth or Wood, or building themselves Cells (s), or fpinning and weaving themselves Cases and Webs. it is all a wonderful Faculty of those poor little Animals, whether we consider their Parts wherewith they work, or their Work it felf. Thus those who perforate the Earth, Wood, or such like, they have their Legs, Feet, Mouth, yea, and Whole Body accommodated to that Service; their Mouth exactly formed to gnaw those handfome

Pare the three States it undergoes after it is hatched, we shall find yet greater Signals of the Creator's Management, even in these meanest of Creatures. The three States I mean, are its Nympha-Vermicular State, its Aurelia, and Mature State, all as different as to Shape and Accourrements, as if the Infect was three different Animals. In its Vermitular-State, it is a Red-Maggot, as I faid, and hath a Mouth and other Parts accommodated to Food: In its Aurelia-State; it hath no fuch Parts, because it then subsists without Food; but in its Mature, Gnat-State, it hath a curious well made Spear, to wound and fuck the Blood of other Animals. In its Vermicular-State, it hath a long Worm-like Body, and something analogous to Fins or Feathers, standing erect near its Tail, and running parallel with the Body, by means of which refifting the Waters, it is enabled to fwim about by Curvations, or flapping its Body, fide-ways, this way and that, as in Fig. 12.

But in its Aurelia-State, it hath a quite different Body, with a Club-Head (in which the Head, Thorax, and Wings of the Gnat are inclosed) a flender Alous, and a neat finny Tail, standing at right Angles with the Body, quite contraty to what it was before; by which Means, instead of easy flapping fide-ways, it fwims by rapid, brilk Jirks, the quite contrary Way; as is in some Measure represented in Fig. 13. But when it becomes a Gnat, no finny Tail, no Club-Head, but all is made in the most accurate Manner for Flight and Mo-

zion in the Air, as before it was for the Waters.

(s) See Book IV. Chap. 13. Notes (n), (o).

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CHAP. VI. Nidification of Infects. 395

In the first Place, 'tis certain that the Formation of those Cases and Balls quite exceeds the Cunning of the Animal it self; but it is the Act partly of the Vegetable, and partly of some Virulency (or what shall I call it?) in the Juice, or Egg, or both, reposited on the Vegetable by the Parent-Animal (bb). And as this Virulency is various, according to the Difference of its Animal, so is the Form and Texture of the Cases and Balls excited thereby; some being hard Shells (cc), some

(bb) What I suspected my self, I find confirmed by Malpighi, who in his exact and true Description of the Fly bred in the Oaken Galls, faith, Non fat fuit nature tam miro artificio Terebram seu Limam condidisse; sed inflicto vulnere, vel excitato foramine infundendum exinde liquorem intra Terebram condidit: quare fracta per transversam muscarum terebra frequentissime, vivente animali, gutta aliquot diaphani humoris effluent. And a little after, he confirms, by ocular Observation, what he imagin'd before, viz. Semel prope Junii finem vidi Muscam, qualem superius delineavi, insidentem quercina gemma, adhuo germinanti; harebat etenim foliolo stabili ab apice biantis gemme erumpenti: & convulso in arcum corpore, terebram evaginabat, ipsamque tensam immittebat ; 🔄 tumefacto ventre circa terebra radicem tumorem excitabat, quem interpolatis vicibus remittebat. In folio igitur, avulsa Musca, minima & diaphana reperi ejecta ova, simillima iis, qua adhuc in tubis supererant. Non licuit iterum idem admirari spectaculum, &c.

Somewhat like this, which Malpighi faw, I had the good Fortune to fee my felf once fome Years ago: And that was, the beautiful, shining Oak-Ban Ichneumen strike its Terebra into an Oak-Apple divers Times, no doubt to lay its Eggs therein. And hence I apprehend we see many Vermicules towards the Outside of many of the Oak-Apples, which I guess were not what the Primitive Insects laid up in the Gem, from which the Oak-Apple had its Rise, but some other supervenient, additional Insects, laid in after the Apple was

grown, and whilst it was tender and fost.

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(a) The Aleppo-Gaus, wherewith we make Ink, may be reckoned of this Number, being hard, and no other than Cases of Insects which are bred in them; who when come to Maturity, gnaw their Way out of them; which is the

396 Nidification of Infects. Book VIII. fome tender Balls (dd), some Scaly (ee), some Smooth

Cause of those little Holes observable in them. Of the Insects bred in them, see Philos. Transact. No. 245. Of this Number also are those little smooth Cases, as big as large Pepper-Corns, growing close to the Ribs under Oaken-Leaves, globous, but flattish; at first touched with a blushing red, afterwards growing brown, hollow within, and an hard thin Shell without. In this lieth commonly a rough, white Maggot, which becomes a little long winged, black lehneumung, that eats a little-Hole in the Side of the Gall, and so

gets out.

(dd) For a Sample of the tender Balls, I shall chuse the globous Ball, as round, and some as big as small Musker-Bullets, growing close to the Ribs, under Oaken-Leaves, of a greenish yellowish Colour, with a blush of red; their Skin smooth, with frequent Risings therein. Inwardly they are very soft and spungy; and in the very Center is a Case with a white Maggot therein, which becomes an Ichneumos-Fly, not much unlike the last. As to this Gall, there is one Thing I have observed somewhat peculiar, and I may say providential, and that is, that the Fly lies all the Winter those Balls in its Infantile-State, and comes not to its Maturity till the following Spring. In the Autumn, and Winter, these Balls fall down with their Leaves to the Ground, and the Insect inclosed in them is there senced against the Winter Frosts, partly by other Leaves falling pretty thick upon them, and especially by the thick, parenchymous, spongy Walls, afforded by the Galls themselves.

Another Sample shall be the large Oak-Balls, called Old Apples, growing in the Place of the Buds, whose Generation Vegetation and Figure, may be seen in Malpig. de Gallis, p. 24 and Tab. 10. Fig. 33, &c. Out of these Galls, he saith various Species of Flies come, but he names only two, and they are the only two I ever saw come out of them: Frequents (saith he) subnigra sunt musica brevi munita terebra. Inter has always observantur aurea, levi viridis tinttura suffusa, oblonga pollette terebra. These two differently coloured Flies, I take to no other than Male and Female of the same Species. I have not observed Tails (which are their Terebra) in all, as Mipighi seems to imitate: Perhaps they were hid in their Thus and I could not discover them: But I rather think they were none, and that those were the Males: But in other I have observed long, recurvous Tails, longer than the whole Bodies. And these I take to be the Females.

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tions to be exceedingly accurate and true, having traced my felf many of the Productions he hath mentioned. But I find Italy and Sicily (his Book de Gallis being published long after he was made Professor of Messina) more luxuriant in such Productions than England, at least, than the Parts about Upminster (where I live) are. For many, if not most of those about us, are taken Notice of by him, and several others besides that I never met with; although I have for many Years as critically observed all the Excrescences, and other morbid Tumors of Vegetables, as is almost possible, and do believe that sew of them have escaped me.

As to the Method how those Gans and Bans are produced, the most simple, and consequently the most easy to be accounted for, is that in the Gems of Oak, which may be called Squamous-Oak-Cones, Capitula squamata, in Malpighi: Whose Description not exactly answering our English-Cones in divers Respects. I shall therefore pass his by, and shew only what

I have observed my self concerning them.

These Cones are, in outward Appearance, perfectly like the Gems, only vailly bigger; and indeed they are no other than the Gems, encreased in Bigness, which naturally ought to be pushed out in Length: The Cause of which Obstruction of the Vegetation is this: Into the very Heart of the young tender Gem or Bud (which begins to be turgid in fune, and to shoot towards the latter End of that Month, or Beginning of the next; into this, I fay) the Parent-Infect hrusts one or more Eggs, and not perhaps without some renemous Ichor therewith. This Egg soon becomes a Magot, which eats it felf a little Cell in the very Heart or Pith f the Gem, which is the Rudiment of the Branch, together vith its Leaves and Fruit, as shall be hereafter shewn. The Branch being thus wholly destroyed, or at least its Vegetaion being obstructed, the Sap that was to nourish it, is dierted to the remaining Parts of the Bud, which are only he scaly Teguments; which by these Means grow large and ourishing, and become a Covering to the Infect-Case, as efore they were to the tender Branch and its Appendage.

The Case lying within this Cone, is at first but small, as he Maggot included in it is, but by degrees, as the Maggot icreaseth, so it grows bigger, to about the Size of a large thite Pease, long and round, resembling the Shape of a small

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The Infest it felf, is (according to the modern Infectoloers) of the Ichneumon-Fly Kind; with four Membranaceous lings, reaching a little beyond the Body, articulated Horns, large Thorax, bigger than the Belly; the Belly short and conical; the Galls and Balls found on the Leaves and Branches of divers Vegetables, such as the Oak, the Wil-

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low (aa), the Briar, and some others.

Now this is so peculiar an Artistice, and so far out of the Reach of any mortal Understanding, Wit, or Power, that if we consider the Matter, with some of its Circumstances, we must needs perceive manifest Design, and that there is the Concurrence of some Great and Wise Being, that hath, from the Beginning, taken Care of, and provided for the Animal's Good: For which Reason, as mean as the Instance may seem, I might be excused, if I should enlarge upon its Particulars. But two or three Hints shall suffice.

whitish, partly black. The Length of the Body from Head to Tail, about is of an Inch; its Colour, a very beautiful shining Green, in some tending to a dark Copper Colour. Figures both of the Cones, Cases, and Insects, may be seen mong Malpighi's Cuts of Galls, Tab. 13. and Tab. 20. Fig. 12. which Fig. 72. exhibits well enough some others of the Galls, but its Thorax is somewhat too short for ours.

(aa) Not only the Willow, and fome other Trees, but Plants alfo, as Nettles, Ground-Ivy, &c. have Cafes produced on their Leaves, by the Injection of the Eggs of an Ichneuman Fly. I have observed those Cases always to grow in, or all joining to some Rib of the Leaf, and their Production! conceive to be thus, viz. The Parent-Infect, with its stiff to taceous Tail, terebrates the Rib of the Leaf, when tender, and makes Way for its Egg into the very Pith or Heat thereof, and probably lays in therewith, some proper Juice of its Body, to pervert the regular Vegetation of it. From this Wound arises a small Excrescence, which (when the Egg is hatched into a Maggot) grows bigger and bigger, as the Maggot increases, swelling on each Side the Leaf between the two Membranes, and extending it felf into the parenchy mous Part thereof, until it is grown as big as two Grains Wheat. In this Case lies a small, white, rough Maggot which turns to an Aurelia, and afterwards to a very beautiful green, fmall Ichnemmon-Fly. (66) Tyba CHAP. VI. Nidification of Insects. 397 Smooth (ff), some Hairy (gg), some Long, some Round, some Conical, Gc. (bb). And in

in the Oak-Apples themselves, I have seen the Aurelia, some with, some without Tails. And I must consess, 'twas not without Admiration as well as Pleasure, that I have seen with what exact Neatness and Artisice, the Tail hath been wrapt about the Aurelia, whereby it is secured from either annoying the Insect, or being hurt it self.

(ee) See before, Note (z).

(ff) As in the preceding Note.

(gg) Of the rough or hairy Excrescences, those on the Briar, or Dog-Rose, are a good Instance. These Spongiola villosa, as Mr. Ray, Galla rumosa, as Dr. Malpighi calls them, are thus accounted for by the latter; Ex copiosis relictis ovis ita turatur affluens [Rubi] succus, ut sirumosa siant complura tubercula smul confuse congesta, qua utriculorum seriebus, & sibrarum implicatione contexta, ramosas propagines germinant, ita ut minima quase plua appareat. Qualibet propago ramos, hinc inde villosos edit. Hine inde pili pariter erumpunt, &c.

These Balls are a safe Repository to the Insect all the Winter in its Vermicular-State. For the Eggs laid up, and atched the Summer before, do not come to mature Insects intil the Spring following, as Mr. Ray rightly observes in

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As to the Infects themselves, they are manifestly Ichneumonlies, having four Wings, their Alvus thick and large towards he Tail; and tapering up till it is small and slender at its etting on to the Thorax. But the Alvi or Bellies are not ake in all, though coloured alike. In some they are as is now lescribed, and longer, without Terebra, or Tails; in some horter with Tails: And in some yet shorter, and thick, like he Belly of the Ant, or the Heart of Animals, as in those efore, Note (2). But for a farther Description of them, I hall refer to Mr. Ray, Cat. Plant. circa Cantab. under Rosa livest.

(bb) It being an Instance somewhat out of the Way, I shall itch upon it for an Example here, viz. The gouty Swellings in he Body, and the Branches of the Blackberry-Bush; of which Malpighi hath given us two good Cuts in Tab, 17. Fig. 62. The Cause of these is manifestly from the Eggs of Insects aid in (whilst the Shoot is young and tender) as far as the Pith, and in some Places not so deep: Which for the Reasons before-mentioned, makes the young Shoots turnify, and

row knotty and gouty.

Midification of Infects. BOOK VIII. the last Place, let us add, That those Species of Infects are all endowed with peculiar and exactly made Parts for this Service, to bore and pierce the Vegetable, and to reach and inject their Eggs and Juice into the tender Parts thereof.

The Infect that comes from hence is of the former Tribe, a small, shining black lehneumon-Fly, about a tenth of an Inch long; with jointed, red, capillary Horns, four long Wings, reaching beyond the Body, a large Thorax, red Legs, and a short heart-like Belly. They hop like Fleas. The Males are less than the Females; are very venerous, endeavouring a Con in the very Box in which they are hatch'd; getting up on the Females, and tickling and thumping them with their Breeches and Horns, to excite them to Venery.

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The CONCLUSION.

AND now these Things being seriously consdered, what less can be concluded, than that there is manifest Design and Forecast in this Case, and that there must needs be some Wise Artist, some Careful, Prudent Conservator, that from the very Beginning of the Existence of this Species of Animals, hath with great Dexterity and Forecast, provided for its Preservation and Good? For what else could contrive and make such a Set of curious Parts, exactly fitted up for that special Purpose: And withal implant in the Body fuch peculiar Impregnations, as should have such a strange uncouth Power on a quite different Rank of Creatures? And lastly, what should make the Infect aware of this its strange Faculty and Power, and teach it fo cunningly and dextroully to employ it for its own Service and Good ?

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BOOK IX.

Of REPTILES, and the Inhabitants of the WATERS.



CHAP. I. Of Reptiles.

AVING dispatch'd the Insect Tribe, there is but one Genus of the Land-Animals remaining to be survey'd; and that is, that of Reptiles (a). Which I shall dispatch in a little Compass, by Reason I have somewhat amply treated of others, and many of the Things

⁽a) Notwithstanding I have before, in Book IV. Chap. 12. Note (p), taken Notice of the Earth-Worm; yet it being a good Example of the Creator's wise and curious Workmanship, in even this meanest Branch of the Creation, I shall superadd a ew farther Remarks from Drs. Willis and Tyson. Saith Willis, Lumbricus terrestris, licet vile & contemptibile habetur, Organa vitata, necnon & alia viscera, & membra divino artissico admirabiliter saresacta sortiur: totius corporis compages musculorum annularium cama est, quorum sibra orbiculares contratta quemque annulum, prius mplum, & dilatum, angustiorem & longiorem reddunt. [This Muscle

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Things may be apply'd here. But there are some Things in which this Tribe is somewhat singular, which I shall therefore take Notice of briefly in this Place. One is their Motion, which I have in another Place (b) taken Notice of to be not less turious, than it is different from that of other Animals, whether we consider the Manner of it, as vermicular, or sinuous (c), or like that of the Snail

Muscle in Earth-Worms I find is spiral, as in a good Meafure is their Motion likewise ; so that by this Means they can, (like the Worm of an Augre,) the better bere their Paffage into the Earth, Their Reptile Motion also, may be explain'd by a Wire would on a Cylinder, which when slipp'd off, and one End extended and held fast, will bring the other nearer it. So the Earth-Worm, having set out, or extended its Body, (which is with a wreathing.) it takes held by those small Feet it bath, and so contracts the hinder Part of its Bets. Thus the curious and learned Dr. Tyfon, Philof. Tranf. No. 147.] Nam proinde, cum portio corporis superior elongata, & exporetta, ad spatium alterius extenditur, ibidemque plano affigitur, adip-Sum quali ad centrum portio corporis inferior relaxata, & abbreviat facile pertrabitur. Pedunculi ferie quadruplici, per totam longitudnem Lumbrici disponuntur; bis quasi totidem uncis, partem modo ham, modo istam, plano affigit, dum alteram exporrigit, aut post se cuit. Supra oris hiatum, Proboscide, qua terram perforat & elevat, donatu. And then he goes on with the other Parts that fall under View, the Brain, the Gullet, the Heart, the Spermatick Visit, the Stomachs and Intestines, the Foramina on the Top of the Back, adjoining to each Ring, supplying the Place of Lung, and other Parts. Willis de Anim. Brut. P. I. c. 3.

(b) In Book IV. Chap. 8.

(c) There is a great deal of Geometrical Neatness and Nicety, in the finuous Motion of Snakes, and other Serpents. For the affisting in which Action, the annular Scales under their Body are very remarkable, lying cross the Belly, contrary to what those in the Back, and the rest of the Body do; also as the Edges of the foremost Scales lie over the Edges of their following Scales, from Head to Tail; so those Edge run out a little beyond, or over their following Scales; so as that when each Scale is drawn back, or set a little upright by its Muscle, the outer Edge thereof, (or Foot it may be call'd,) is rais'd also a little from the Body, to lay hold of the set of the Body, to lay hold of the set of the Body, to lay hold of the set of the Body, to lay hold of the set of the Body, to lay hold of the Body is rais'd also a little from the Body, to lay hold of the Body is rais'd also a little from the Body, to lay hold of the Body is rais'd also a little from the Body, to lay hold of the Body is rais'd also a little from the Body, to lay hold of the Body is rais'd also a little from the Body, to lay hold of the Body is rais'd also a little from the Body is lay hold of the Body is rais'd also a little from the Body is lay hold of the Body is rais'd also a little from the Body is lay hold of the Body is rais'd also a little from the Body is lay hold of the Body is lay hold of the Body is a lattle from the Body is lattle from t

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Snail (d), or the Caterpillar (e), or the Multipedous (f), or any other Way; or the Parts miniftring

the Earth, and so promote and facilitate the Serpent's Motion. This is what may be easily seen in the Slough, or Belly of the Serpent-kind. But there is another admirable Piece of Mechanism, that my Antipathy to those Animals hath prevented my prying into; and that is, that every Scale hath a distinct Muscle, one End of which is tack'd to the Middle of its Scale; the other, to the upper Edge of its sollowing Scale. This Dr. Tyson found in the Rattle-Snake,

and I doubt not is in the whole Tribe.

(d) The Wise Author of Nature, having deny'd Feet and Claws to enable Snails to creep and climb, hath made them amends in a Way more commodious for their State of Life, by the broad Skin along each Side of the Belly, and the undulating Motion observable there. By this latter it is they reep; by the former, affished with the glutinous Slime emitted from the Snail's Body, they adhere firmly and securely to all Kinds of Superficies, partly by the Tenacity of their Slime, and partly by the Pressure of the Atmosphere. Concerning this Part, (which he calls the Snail's Feet, and their Undulation, see Dr. Lister's Exercit. Anat. 1. sett. 1, and 37.

(e) The motive Parts, and Motion of Caterpillars, are useul, not only to their Progression and Conveyance from Place o Place; but also to their more certain, easy, and commodius gathering of Food. For having Feet before and behind. hey are not only enabled to go by a Kind of Steps made by heir fore and hind Parts; but also to climb up Vegetables, nd to reach from their Boughs and Stalks for Food at a Ditance; for which Services, their Feet are very nicely made oth before and behind. Behind, they have broad Palms for ticking too, and these beset almost round with small sharp Vails, to hold and grasp what they are upon: Before, their feet are sharp and hook'd, to draw Leaves, &c. to them, and o hold the fore-part of the Body, whilst the hinder-parts are rought up thereto. But nothing is more remarkable in these Reptiles, than that these Parts and Motion are only tempoary, and incomparably adapted only to their present Nymba-State; whereas in their Aurelia-State, they have neither feet nor Motion, only a little in their Hinder-parts: And n their Mature-State, they have the Parts and Motion of a ying Infect, made for Flight.

(f) It is a wonderful pretty Mechanism, observable in the

string to it, particularly the Spine (g), and the Muscles co-operating with the Spine, in such as have Bone, and the annular, and other Muscles, in such as have none, all incomparably made for those curious, and I may say, geometrical Windings and Turnings, Undulations, and all the various Motions to be met with in the Reptile Kind.

Another Thing that will deserve our Notice, is, the Poyson (b) that many of this Tribe are stock'd with.

going of Multipedes, as the Juli, Scolopendra, &c. that on each Side the Body, every Leg hath its Motion, one very regularly following the other from one End of the Body to the other, in a Way not easy to be describ'd in Words; so that their Legs in going, make a kind of Undulation, and give the Body a swifter Progression than one would imagine it should have, where so many Feet are to take so many short Steps.

(g) Vertebrarum Apophyses breviores sunt, pracipue juxta caput, cujus propterea stexus in aversum, & latera, facilis Viperis est: secus
Leonibus, &c.——Incumbit his Osibus ingens Musculorum minutorum prasidium, tum spinas tendinum exilium magno apparatu diducentium, tum vertebras potissimum in diversa stettentium, atque erigentium. Adeoque illam corporis miram agilitatem, non tantum sut
Aristot.) Tre evaquesis nei xorsposesse se anovovos quoniam
faciles ad stexum, & cartilagineas produxit vertebras, sed quia etiam
multiplicia motus localis instrumenta musculos sabrefecit provida rerum
Parens Natura, consecuta suit. Blas. Anat. Anim. P. 1. c. 39.
de Viperà è Veslingio.

That which is most remarkable in the Vertebræ [of the Rattle-Snake, besides the other curious Articulations,] is, that the round Ball in the lower Part of the upper Vertebra, enters a Socket of the upper Part of the lower Vertebra, like as the Head of the Os Femoris doth the Acetabulum of the Os Ischii; by which Contrivance, as also the Articulation with one another, they have that free Motion of winding their Bodies any way. Dr. Tyson's Anat. of the Rattle-Snake in Philos. Trans. No. 144. What is here observed of the Vertebræ of this Snake, is common to this whole Genus of Reptiles.

(b) My ingenious and learned Friend, Dr. Mead, examined with

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with found in the thefe is and States for present P. 9. As ingen

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est fr Antid the Cu adies there with. Which I the rather mention, because some make it an Objection against the Divine Super-intendence and Providence, as being a Thing so far from useful, (they think,) that 'tis rather mischievous and destructive of God's Creatures. But the Answer is easy, viz. That as to Man, those Creatures are not without their great Uses, particularly in the Cure of (i) some of the most stub-born

with his Microscope, the Texture of a Viper's Poyson, and found therein at first only a Parcel of small Salts nimbly floating in the Liquer; but in a short Time the Appearance was chang'd, and these saline Particles were shot out into Crystals, of an incredible Tenuity and Sharpness, with something like Knots here and there, from which they seem'd to proceed; so that the whole Texture did in a Manner represent a Spider's Web, though infinitely siner. Mead of Poysons, p. 9.

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As to the Nature and Operation of this Poylon, see the same ingenious Author's Hypothesis, in his following Pages:

This Poyson of the Viper lieth in a Bag in the Gums, at the Upper-end of the Teeth. It is separated from the Blood by a conglomerated Gland, lying in the anterior lateral Part of the Os Sincipitis; just behind the Orbit of the Eye: From which Gland lieth a Duct, that conveys the Poyson to the Bags at the Teeth.

The Teeth are tubulated, for the Conveyance, or Emission of the Poyson into the Wound the Teeth make; but their Hollowness doth not reach to the Apex, or Top of the Tooth, (that being solid and sharp, the better to pierce;) but it ends in a long slit below the Point, out of which the Poyson is emitted. These Perforations of the Teeth, Galen saith, the Mountebanks us'd to stop with some kind of Paste, before they suffer'd the Vipers to bite them before their Spectators, Cuts of these Parts, &c. may be seen in the last cited Book of Dr. Mead. Also Dr. Tyson's Anat. of the Rattle-Snake, in Phil. Trans. No. 144.

(i) That Vipers have their great Uses in Physick, is manifelf from their bearing a great Share in some of our best Antidotes, such as Theriaca Andromachi, and others; also in the Cure of the Elephantiasis, and other the like stubborn Maddies, for which I shall refer to the medical Writers. But there is so singular a Case in the curious Collection of Dr. Ol.

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404 Of Reptiles. BOOKIX

born Diseases; however, if they were not, there would be no Injustice for God to make a Set of such noxious Creatures, as Rods and Scourges, to execute the Divine Chastisements upon ungrateful and finful Man. And I am apt to think that the Nations which know not God, are the most annoyl with those noxious Reptiles, and other pernicions

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Worm, related from Kircher, that I shall entertain the Reader with it. Near the Village of Sassa, about eight Miles from the City Bracciano in Italy, faith he, Specus feu caverna (una La Grotta delli Serpi) duorum hominum capax, fiftulosis quibusian foraminibus in formam cibri perforata cernitur, ex quibus ingens que dam, principio veris, diversicolorum Serpentum, nulla tamen, ut dicita fingulari veneni qualitate imbutorum progenies quotannis pullulare let. In bac spelunca Elephantiacos, Leprosos, Paralyticos, Arthritia Podagricos, &c. nudos exponere solent, qui mox halituum subterun orum calore in sudorem resoluti, Serpentum propullulantium, totum a pus infirmi implicantium, suctu linctuque ita omni vitioso virulenta humore privare dicuntur, ut repetito hoc per aliquod tempus media mento, tandem perfecta sanitati restituantur. This Cave Kink visited himself, found it warm, and every Way agreeables the Description he had of it; he saw their Holes, heard murmuring histing Noise in them; but although he mills feeing the Serpents, (it being not the Season of their cree ing out) yet he saw great Numbers of their Exuvia, or Slong and an Elm growing hard by laden with them.

The Discovery of this Cave, was by the Cure of a Lagoing from Rome to some Baths near this Place; who loss his Way, and being benighted, happened upon this Cave and finding it very warm, pull'd off his Clothes, and been weary and sleepy, had the good Fortune not to feel the sepents about him till they had wrought his Cure. Vide M

Jeum Worm - 1. 3. c. 9.

The before-commended Dr. Mead, thinks our Physics deal too cautiously and sparingly, in their prescribing of small Quantities of the Viper's Flesh, &c. in the Elephantia and stubborn Leprosics: But he recommendeth rather Gelly or Broth of Vipers; or, as the Ancient Manner to boil Vipers, and eat them like Fish; or at least to drive Wine, in which they have been long intused. Vide Mead, supra, p. 34.

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Creatures. As to the Animals themselves, their Poison is, no doubt, of some great and especial Use to themselves, serving to the more easy Conquest, and sure Capture of their Prey, which might otherwise be too resty and strong, and if once escap'd, would hardly be again Recover'd, by Reason of their swifter Motion, and the Help of their Legs; besides all which, this their Poison may be probably of very great Use to the Digestion of their Food.

And as to the innocuous Part of the Reptile-Kind, they as well deserve our Notice for their Harmlesness, as the others did for their Poison. For as those are endow'd with Poison, because they are predaceous; so these need it not, because their Food is near at Hand, and may be obtain'd without Strife and Contest, the next Earth (k) affording Food to such as can terebrate, and make Way into the their Vermicular Faculty; and the next Vegetable being Food to others that can climb and each (1), or but crawl to it.

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⁽k) That Earth-worms live upon Earth, is manifest from the ttle curled Heaps of their Dung ejected out of their Holes. Sut in Philof. Trans. No. 291, I have faid, it is in all Probabity Earth made of rotted Roots and Plants, and such like utritive Things, not pure Earth. And there is farther teason for it, because Worms will drag the Leaves of Trees ato their Holes.

⁽¹⁾ Snails might be in Danger of wanting Food, if they were to live only upon such tender Plants as are near the fround, within their Reach only; to impower them there are to extend their Pursuits farther, they are enabled by the seans mentioned in Note (d), to stick unto, and creep up Valls and Vegetables at their Pleasure.

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CHAP. II. Of the Inhabitants of the Waters,

Have now gone through that Part of the Animal World, which I proposed to survey, the Animals

inhabiting the Land.

As to the other Part of the Terraqueous Globe, the Waters, and the Inhabitants thereof, not having Time to finish what I have begun on that large Subject, I shall be forced to quit it for the present, altho' we have there as ample and glorious a Scene of the Infinite Creator's Power and Art, as hath been already set forth on the dry Land. For the Waters themselves are an Admirable Work of God (a), and of Infinite Use (b) to

(a) Besides their absolute Necessity, and great Use to the World, there are several Topics, from whence the Water may be demonstrated to be God's Work; as, the creating to wast a Part of our Globe; the placing it commodiously therein, and giving it Bounds; the Methods of keeping it sweet and clean, by its Saltness, by the Tides, and Agitations by the Winds; the making the Waters useful to the Vegetation of Plants, and for Food to Animals, by the noble Methods of sweetning them; and many other Things besides, which are insisted on in that Part of my Survey.

(b) Pliny having named divers Mirabilia Aquarum, to shew their Power; then proceeds to their Uses, viz. Eadem cadentees omnium terra nascentium causa siunt, prorsus mirabili natura, si quis velit reputare, ut fruges gignantur, arbores fruticesque vivant, in ecolum migrare aquas, animamque etiam berbis vitalem inde deservi justa consessione, omnes terra quoque vires aquarum esse beneficii. Quapropter ante omnia ipsarum potentia exempla ponemus: Cunstas enim quis mortalium enumerare queat? And there he goes on with an Enumeration of some Waters samed for being Medicinal, of some other unusual Quality. Plin. 1. 31. c. 1, 6. 2.

that Part of the Globe already survey'd; and the prodigious Variety (c), and Multitudes of curious and wonderful Things observable in its Inhabitants of all Sorts, are an inexhaustible Scene of the Creator's Wisdom and Power. The vast Bulk of some (d), and prodigious Minuteness of others (e), together with the incomparable Contrivance and Structure of the Bodies (f) of all; the Provisions and Supplies of Food afforded to such an innumerable Company of Eaters, and that in an Element, unlikely, one would think, to afford any great Store

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(c) Pliny reckons 176 Kinds in the Waters, whose Names may be met with in his 1. 32. 0. 11. but he is short in his Account.

(d) Pliny, l. 9. c. 3. faith, That in the Indian Sea there are Balena quaternûm jugerum (i. e. 960 Feet) Pristes 200 cubitorum (i. e. 300 Feet.) And l. 32. c. 1. he mentions Whales 600 Feet long, and 360 broad, that came into a River of Arabia. If the Reader hath a Mind, he may see his Reason why the largest Animals are bred in the Sea, l. 9. c. 2.

(e) As the largest, so the most minute Animals are bred in the Waters, as those in Pepper-water; and such as make the green Scum on the Waters, or make them seem as if green, and many others. See Book IV. Chap. 11. Note (n), (o).

(f) It might be here shewn, that the Bodies of all the several Inhabitants of the Waters, are the best contrived and suited to that Place and Business in the Waters, which is proper for them; that particularly their Bodies are cloathed and guarded, in the best Manner, with Scales, or Shells, &c. suitble to the Place they are to refide in, the Dangers they may here be exposed unto, and the Motion and Business they are here to perform: That the Center of Gravity (of great Conideration in that fluid Element,) is always plac'd in the fittest Part of the Body: That the Shape of their Bodies, (especially he more swift,) is the most commodious for making Way brough the Waters, and most agreeable to geometrical Rules; and many other Matters besides would deserve a Place here, were they not too long for Notes, and that I shall anticipate what shall be more proper for another Place, and more accutately treated of there. Dd 4 (g) See of Supplies (g); the Business of Respiration perform'd in a Way so different from, but equivalent to what is in Land Animals (b); the Adjustment of the Organs of Vision (i) to that Element in which the Animal liveth; the Poise (k), the Support (l), the Motion of the Body (m), forwards with

(g) See before Book IV. Chap. 11.

(b) Galen was aware of the Respiration of Fishes by their Branchia. For having said, that Fishes have no Occasion of a Voice, neither respire through the Mouth as Land Animals do, he saith, Sed earum, quas Branchias nuncupamus, constructio, ipsts vice Pulmonis est. Cum enim crebris ac tenuibus foraminihus sint Branchia ha intercepta, aeri quidem & vapori perviis, subtilioribus tamen quam pro mole aqua; hanc quidem extra repellunt, illa autem prompte intromittunt. Galen de Us. Part. 1. 6. c. 9. So also Pliny held, That Fishes respired by their Gills; but he saith Aristotle was of a different Opinion. Plin. 1. 9. c. 7. And so Aristotle seems to be in his History of Animals, 1. 8. c. 2. and in other Places. And I may add our famous Dr. Needham. See his De form. Fatu, Chap. 6. and Answer to Severinus.

(i) A protuberant Eye would have been inconvenient for Fishes, by hindring their Motion in so dense a Medium as Water is; or else their brushing through so thick a Medium would have been apt to wear, and prejudice their Eyes; therefore their Cornea is flat. To make Amends for which, as also for the Refraction of Water, different from that of the Air, the Wise Contriver of the Eye, hath made the Crystalling spherical in Fishes, which in Animals, living in the Air, is

denticular, and more flat.

(k) As I have shewed before, that the Bodies of Birds are nicely pois'd to swim in the Air; so are those of Fishes for the Water, every Part of the Body being duly balanc'd, and the Center of Gravity (as I said in Note (f), accurately fix'd. And to prevent Vacillation, some of the Fins serve, particularly those of the Belly; as Borelli prov'd, by cutting off the Belly-fins, which caus'd the Fish to reel to the right and less Hand, and render'd it unable to stand steadily in an upright Posture.

(1) To enable the Fish to abide at the Top, or Bottom, or any other Part of the Waters, the Air-Bladder is given to most Fishes, which as it is more full or empty, makes the Body

more or less buoyant.

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with great Swiftness, and upwards and downwards with great Readiness and Agility, and all without Feet and Hands, and ten thousand Things besides; all these Things, I say, do lay before us so various, so glorious, and withal so inexhaustible a Scene of the Divine Power, Wisdom and Goodness, that it would be in vain to engage my self in so large a Province, without alotting as much Time and Pains to it, as the preceding Survey hath cost me. Passing by therefore that Part of our Globe, I shall only say somewhat very briefly concerning the insense tive Creatures, particularly those of the veget able Kingdom, and so conclude this Survey.

(m) The Tail is the grand Instrument of the Motion of the Body; not the Fins, as some imagine. For which Reason, Fishes are most musculous and strong, in that Part, than in all the rest of their Body, according as it is in the motive Parts of all Animals, in the pectoral Muscles of Birds, the Thighs of Man, &c.

If the Reader hath a Mind to see the admirable Method, how Fishes row themselves by their Tail, and other Curiosities relating to their Swimming; I shall refer him to Borelli de mot. Animal, Part 1. Chap. 23. particularly to Prop. 213.

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BOOK X.

Of VEGETABLES.

HE Vegetable Kingdom, although an inferior Branch of the Creation, exhibits to us such an ample Scene of the Creator's Contrivance, Curiosity, and Art, that I much rather

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ther chuse to shew what might be said, than engage too far in Particulars. I might insist upon the great Variety there is, both of Trees and Plants provided for all Ages, and for every Use and Occasion of the World (a); some for Building, some some some long and Utensils of every Kind; some hard, some long and tall, some short and low; some thick and large, some small and slender; some for Physick (b), some for Food, some for Pleasure; yea, the most abject (c) Shrubs, and the very Bushes

(a) The fifth Book of Theophrastus's History of Plants may be here consulted; where he gives ample Instances of the various Constitutions and Uses of Trees, in various Works, &c. See

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alfo before, Book IV. Chap. 13. Note (a).

(b) Invisis quoque berbis inseruit [Natura] remedia: quippe un medicinas dederit etiam aculatis—in quibus ipsis providentiam Natura satis admirari amplettique non est.—Inde excogitavit aliqui aspectio bispidas, tattu truces, ut tantum non vocem ipsius singentisilas, rationemque veddentis exaudire videamur, ne se depascat avida Quadrupes, ne procaces manus rapiant, ne negletta vestigia obterant, u insidens Ales infringat: his muniendo Aculeis, telisque armando, nmediis ut tuta ac salva sint. Ita boc quoque quod in iis odimus, liminum causa excogitatum. Plin. Nat. Hist. 1. 22. c. 6.

Are some of the Species of Nature noxious? They are also useful.

— Doth a Nettle sting? It is to secure so good a Medicine from the Rapes of Children and Cattle. Doth the Bramble cumber a Garden! It makes the better Hedge; where if it chanceth to prick the Owner, it will tear the Thief. Grew. Cosmolog. lib. 3. cap. 2. sect. 47.

(c) That the most abject Vegetables, &c. have their Use, and are beneficial to the World, may in some Measure appear from the Use the Northern People put rotten Wood, &c. unto. Satis ingeniosum modum habent populi septentrionales in nemvibus no unto tempore pertranseuntes, imo & diurno, quando in remvibus no aquilonis partibus ante, & post Solstitium-hyensale continua no unites babentur. Quique his remediis indigent, Cortices quercinos in quirunt putres, oasque collocant certo intersitio itineris institui, at the rum splendore, quo voluevint, persiciant iter. Nec solum hoc prasta Cortex, sed & Truncus putrefattus, ac sungus ipse Agaricus appellatus, &c. Ol. Mag. Hist. 1. 2. c. 16.

Anatomy of Vegetables. Book X. Bushes and Brambles themselves, the Husbandman can testify the Use of.

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I might also Survey here the curious Anatomy and Structure of their Bodies (d), and shew the admirable Provision made for the Conveyance of the lymphatick and effential Juices, for communicating the Air, as necessary to Vegetable, as Animal Life (e): I might also speak of, even the very

Covering

To this we may add Thiftles in making Glass, whose Ashes Dr. Merret saith, are the best, viz. the Ashes of the Commonway Thiftle, though all Thiftles serve to this Purpose. Next to Thistles are Hop-strings, cut after the Flowers are gathered. Plants that are Thorny and Prickly, seem to afford the best and most Salt. Merret's Observations on Anton. Ner. p. 265.

Quid majora sequar? Salices, bumilesque Genifie. Aut illa pecori frondem, aut pastoribus umbram Sufficiunt, Sepemque Satis, & pabula metti.

Virg. Georg. lib. 2. ver. 434.

(d) Dr. Beal (who was very curious, and tried many Experiments upon Vegetables) gives some good Reasons to magine, that there is a direct Communication between the Parts of the Tree and the Fruit, so that the same Fibres which constitute the Root, Trunk, and Boughs, are extendd into the very Fruit. And in old Horn-beams, I have oberved fomething very like this; in many of which, there re divers great and small Ribs (almost like Ivy, only united o the Body) running from the Root up along the outfide f the Body, and terminating in one fingle, or a few Boughs: Which Bough or Boughs spread againinto Branches, Leaves. nd Fruit. See what Dr. Beal hath in Lowth. Abridg. Vol. 2. 0. 710.

But as to the particular Canals, and other Parts relating to he Anatomy of Vegetables, it is too long a Subject for this Place, and therefore I shall refer to Seign. Malpighi's and Dr.

rew's Labours in this Kind.

⁽e) Tanta est Respirationis necessitas, & usus, ut Natura in singulis iventium ordinibus varia, sed analoga, paraverit instrumenta, qua fulmones weamus [and so he goes on with observing the Aparatus made in the various Genera of Animals, and then faith] Plantis verg, que infimum animalium attingunt ordinem, tantam

Anatomy of Vegetables. BOOK X. Covering they are provided with, because it is a curious Work in Reality, although less so in Appearance: And much more therefore might I survey the neat Variety and Texture of their Leaves (f).

Trashearum copiam & productionem extare par est, ut his minime Vegetantium partes prater corticem irrigentur.—Plantæ igitur (ut conjectari fas est) cum sint viventia, visceribus insixa terræ, ab hac seu potius ah aqua & aëre, commixtis & percolatis à terræ, Respirationis sua materiam resipium, ipsarumque Tracheæ ab halitu terræ, extremas radices subingresso, replentur. Malpig. Op. Anat. Plant.

These Trachea or Air-Vessels, are visible, and appear very pretty in the Leaf of Scabious, or the Vine, by pulling a sunder some of its principal Ribs, or great Fibres; between which, may be seen the Spiral Air-Vessels (like Threads of Cob-web) a little uncoiled: A Figure whereof, Dr. Grew hath given us in his Anat. Plant. Tab. 51, 52.

As to the curious coiling, and other Things relating to the Structure of those Air-Vessels, I refer to Malpig. p. 14. and Dr. Grew, ib. 1. 3. c. 3. sett. 16, &c. and 1. 4. c. 4. sett. 19. of Mr. Ray, from them succinctly. Hist. Plant. 1. 1. c. 4.

(f) Concerning the Leaves, I shall Note only two or three Things. 1. As to the Fibres of the Leaf, they stand not in the Stalk, in an even Line, but always in an Angular, or Circular Posture, and their vascular Fibres or Threads, are 3, 5, or 1. The Reason of their Position thus, is for the more erect Growth and greater Strength of the Leaf, as also for the Security of its Sap. Of all which see Dr. Grew, 1. 1. c. 4. set. 8, &c. and 1. 4. par, 1. c. 3. also Tab. 4. Fig. 2, to 11. Another Observable in the Fibres of the Leaf, is their orderly Position, so as to take in an eighth Part of a Circle, as in Mallows; in some a

Syringa. Id. ib. Tab. 46, 47.

2. The Art in Folding up the Leaves before their Eruption out of their Gems, &c. is incomparable, both for its Elegancy and Security, viz. In taking up (so as their Forms will bear) the least Room; and in being so conveniently couched as to be capable of receiving Protection from other Parts, or of giving it to one another, c.g. First, there is the Bow-lap, where the Leaves are all laid somewhat convexly one over another, but not plaited but where the Leaves are not so thick set, as to stand in the Bow-lap, there we have the Pleasure, or the Blat-lap; as in Rose-trees, &c. And so that curious

tenth, but in most a twelfth, as in Holy-Oak; or a fixth, as in

BOOK X. Flowers and Seed of Vegetables.413 the admirable Finery, Gaiety, and Fragrancy of their Flowers (g). I might also inquire into the wonderful Generation and Make of the Seed (b),

Observer goes on shewing the various Foldings, to which he gives the Names of the Duplicature, Multiplicature, the Forerowl, Back-rowl, and Tre-rowl, or Treble-rowl. Grew. ib.l. 1.c. 4. fett. 14, &c. To these he adds some others. l. 4. P. 1.c. 1. fett. 9. Consult also Malpig. de Gemmis, p. 22, &c.

To these curious Foldings, we may add another noble Guard by the Interposition of Films, &c. of which Dr. Grew saith, there are about six Ways, viz. Leaves, Surfoils, Interfoils, Stalks, Hoods, and Mantlings. Grew, ib. and Tab. 41, 42. Mal-

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(g) In the Flower may be confidered the Empalement, as Dr. Grew; the Calix, or Perianthium, as Mr. Ray, and others, call it, defigned to be a Security, and Bands, to the other Parts of the Flower. Floris velut basis & fulcimentum est. Ray Hist. 1. 1. c. 10. Flowers, whose Petala are strong (as Tulips) have no Calix. Carnations, whose Petala are long and slender, have an Empalement of one Piece: And others, such as the Knap-weeds, have it confishing of several Pieces, and in divers Rounds, and all with a counterchangeable Respect to each other, for the greater Strength and Security of themselves, and the Petals, &c. they include.

The next is the Foliation, as Dr. Grew, the Petala, or Folia, as Mr. Ray, and others. In these, not only the admirable Beauty, and luxuriant Colours are observable, but also their curious Foldings in the Calix, before their Expansion. Of which Dr. Grew hath these Varieties, viz. The Close-Couch, as in Roses; the Concave-Couch, as in Blattaria flore albo; the Single-Plait, as in Pease-Blossoms; the Double-Plait, as in Blue-Bottles, &c. the Couch and Plait together, as in Marigolds, &c. the Rowl, as in Ladies-Bower; the Spire, as in Mallows; and lastly, the Plait and Spire together, as in Convolvulus Doronici folio. Lib. 1. cap.

5. feet. 6. and Tab. 54.

As to the Stamina with their Apices, and the Stylus, (called the Attire, by Dr. Grew,) they are admirable, whether we confider their Colours, or Make, especially their Use, if it be as Dr. Grew, Mr. Ray, and others imagine, namely, as a Male Sperm, to impregnate and fructify the Seed. Which Opinion is corroborated by the ingenious Observations of Mr. Samuel Morland, in Philos. Trans. No. 287.

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414Flowers and Seed of Vegetables. BOOK X.

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and the great Usefulness of their Fruit: I might shew that the Rudiments and Lineaments of the Parent-Vegetable, though never so large and spacious, is locked up in the little Compass of their Fruit or Seed, though some of these Seeds are scarce visible to the naked Eye (i). And for a funch as

Reliqua usus alimentique gratid genuit [Natura] ideoque secula annosque tribuit iis. Flores verò odoresque in diem gignit: magna (ut palamest) admonitione bominum, qua spettatissimè storeant, celerimi marcescere. Plin. Nat. Hist. 1. 21. c. 1.

(b) As to the curious and gradual Process of Nature in the Formation of the Seed or Fruit of Vegetables, Cuts being necessary, I shall refer to Dr. Grew, p. 45, and 209, and Mal-

pig. p. 57.

(i) Vetus est Empedoclis dogma, Plantarum semina Ova esse, ab sissem decidua—Inest in eo [Ovo vel Semine) velut in cicatrice, non solo viventis carina, sed cum minimo trunco assurgentes partes, Gemma scilicet, & insignis radicis Canus, &c. Malpig. ib. p. 81. vid. plura in tract. de Seminum veget. p. 14. & passim.

In Malpighi's Life, a Debate may be feen between him and Seign. Triumphetti, the Provost of the Garden at Rome, whether the whole Plant be actually in the Seed. The Affirmative is maintained by Malpighi, with cogent Arguments; among which, this is one: Non praoccupata mente, oculis microscopio armatis, lustret quaso Phaseolorum, seminalem plantulam nondum sasam, in qua folia flabilia, bacque ampla evidenter observabit : in eaden pariter gemmam, nodos, seu implantationes varias foliorum caulis deprehendet. Caulem insignem fibris ligneis, & utriculorum seriebus constantem conspicue attinget. And whereas S. Triumphetti had objected, that vegetatione, metamorphose, inedia plantas in alias degenerare, ut exemplo plurium [constat] pracipue tritici in lolium. & lolis in triticum versi. In Answer to this, (which is one of the strongest Arguments against Malpighi's Affertion) Malpighi replies. Nondum certum est de integritate. & successu experimenti, nam facienti mibi. & amicis, tritici metamorphosis non cessit. Admisa tamen metamorphofi, quoniam bac neglecta cultura, aut vitio soli, aut aeris contingit-ideo ex morboso & monfruoso affectu non licet infert permanentem statum à Natura intentum. Observo plantas sylvestres cultura varias reddi. &c. I have more largely taken Notice of Malpighi's Answer, because he therein shews his Opinion about the Transmutation of Vegetables. Vid. Malpig. Vit. p. 67. So BOOK X. Flowers and Seed of Vegetables. 415 the Perpetuity and Safety of the Species depends upon the Safety of the Seed and Fruit in a great Mea-

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So Mr. Lewenhoeck, after his nice Observations of an Orange-Kernel, which he made to germinate in his Pocket, &c. concludes, Thus we see, how small a Particle, no bigger than a course Sand (as the Plant is represented) is increased, &c. A plain Demonstration, that the Plant, and all belonging to it, was actually in be Seed, in the young Plant, its Body, Root, &c. Philos. Trans. No. 287. See also Raii Cat. Cant. in Acer. mas. from Dr. Highwore. But in all the Seeds which I have viewed, except he Maple, the Plant appears the plainest to the naked Eye, and also very elegant, in the Nux Vomica.

Natura non observat magnitudinis proportionem inter semina & planas ab iisdem ortas, ita ut majus semen majorem semper producat planam, minus minorem. Sunt enim in genere berbarum non pauca, quaam semina arborum nonnullarum seminibus non dico aqualia sunt, sed aulto majora. Sic v. g. Semina Faba, &c. semina Ulmi. &c. multis

cibus magnitudine superant. Raii ubi suprà, l. r. c. 13.

Filicem reliquasque Capillares berbas Semine carere Veteres plerique -prodidere ; quos etiam secuti sunt è Recentioribus nonnulli. Dodous, &c. ___Alii è contrà, Bauhinus, &c. Filices & congeneres rmatophoras esse contendunt; Partim quia Historia Creationis, Gef. ii. 12, &c. - Hanc fententiam verifimam effe __ autopfia wincit. Fredericus Cesius, he saith, was the first that discored these Seeds with the Help of a Microscope. ce him, Mr. W. C. hath more critically observed them. mong other Things observed by that ingenious Gentleman. e these. Pixidula seu capsula semina continentes in plerisque boc us plantis perquam exili granulo arenæ vulgaris cinerea plus duplo nores sunt; imò in nonnullis speciebus vix tertiam quartamve area partem magnitudine aquant, vesicularum quarundam annulis aut tiolis vermiformibus obvolutarum speciem exhibentes. Nonnulla ex vesiculis 100 circiter semina continere deprehendebanturmia parvitate ut nudo oculo prorsus essent invisibilia, nec nist microii interventu detegi possent. — Osmunda Regalis, qua alsis omni-Filicis speciebus mole—antecellit—vascula seminalia obtinet ie cum reliquis congeneribus magnitudinis—quorum immensa 💝 um fugiens parvitas cum magnitudine planta collata ____adeò nulgerere proportionem invenietur, ut tantam plantam è tantillo semine uci attentum observatorem meritò in admirationem rapiat. Ray, d. l. 3. p. 132. This W. C. was Mr. Wil. Cole, as he ownin a Letter I have now in my Hands of his to Mr. Ray, Octob. 18. 1684.

(k) Vege-

Measure, I might therefore take Notice of the peculiar Care the Great God of Nature hath taken for the Conservation and Sasety hereof: As particularly in such as dare to shew their Heads all the Year, how securely their Flower, Seed or Fruit is locked up all the Winter, together with their Leaves and Branches, in their Gems (k), and well fenced and covered there with neat and close Tunicks. And for such as dare not so to expose themselves, with what Sasety are they preserved under the Coverture of the Earth, in their Root (1)

(k) Vegetantium genus, ut debitam magnitudinem sortiatur, & summortalitatus jasturam successiva prolis eductione reparet, statis tempubus novas promit partes, ut tandem emergentes Uteri, recentes das Soboles. Emanantes igitur à caule, caudice, ramis, & radicibus vella bujusmedi partes, non illico laxata extenduntur, sed compendique dam congmentata intra solii axiliam cubantes, non parum substitus Gemma appellantur, &c. And then that great Man goes on shew the admirable various Methods of Nature, in repositing in that little Compass, so large a Part of a Tree or Planthe curious Structure of the Gems, the admirable Gun afforded them, and the Leaves, Flowers and Seed contains in them, &c. Of which having taken Notice before, I plant over it now, and only refer to our Author Malpighi, and Berew, in the Places cited in Note (f) and (g).

(1) Of Bulbous, and a great many more, probably of the far greater Number of Perennial Roots of Herbs, as Am Rape-Crowfoot, &c. it is very observable, that their Root annually renewed, or repaired out of the Trunk or Stalk self; that is to say, the Basis of the Stalk continually, and insensible Degrees descending below the Surface of the East and hiding it self therein, is thus both in Nature, Place a Office, changed into a true Root. —So in Brownwort, a Basis of the Stalk sinking down by Degrees, till it lies and Ground, becomes the upper Part of the Root; and containing still to sink, the next Year becomes the lower Pan And the next after that, rots away; a new Addition best still yearly made out of the Stalk, as the elder Parts year to away. Grew, ibid, 1, 2, 2, 59, ubi plura vid.

Book X. Flowers and Seed of Vegetables. 417
Seed (m), or Fruit, till invited out by the kindly
Warmth of the Spring! And when the whole Vegetable Race is thus called out, it is very pretty to
observe the Methods of Nature in guarding those
insensitive Creatures against Harms and Inconveniencies, by making some (for Instance) to lie down
prostrate, and others, to close themselves up (n)
upon the Touch of Animals, and the most to shut
up their Flowers, their Down (o), or other their

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(m) How safe and agreeable a Conservatory the Earth is o Vegetables, more than any other, is manifest from their otting, drying, or being rendred infecund in the Waters, or he Air; but in the Earth their Vigour is long preserved. Thus Seeds particularly, Mr. Ray thinks some, may probably retain their Fecundity for ten Years, and others lose it in ive; but, saith he, In terra gremio latitantia, quamvis tot caloris, rigoris, humbris & siccitatis varietatibus ibidem obnoxia, diutius tamen ut puto) fertilitatem suam tuentur quam ab hominibus diligentissime ustodita; nam & ego & alii ante me multi observarunt Sinapeos vim aagnam enatam in aggeribus sossantin factis inque areis gramieis essoss, ubi post hominum memoriam nulla unquam Smape's seges accreverat. Quam tamen non sponte ortam suspicor, sed è seminibus terra per tot annos residuis etiam prolificis. Ray. Hist. Pl. 1. 1.

(n) Planta nonnulla Aschynomena Veteribus dieta, Recentioribus iva, & Sensitiva, & Mimosa, haud obscura sensus indicia produnt; quidem folia earum manu aut baculo taeta, & paululum compressa, eno etiam meridie, splendente Scle, illico se contrahunt; in nonnullis iam speciebus cauliculi teneriores concidunt & velut marescunt; quod dem ab aere frigidiore admissa patiuntur. Ray Hist. Pl. T. 1. 1. 18. App. S. 2. c. 2. p. 978.

(0) I have observed that many, if not most Vegetables, do xpand their Flowers, Down, &c. in warm, Sun-shiny Weaner, and again close them towards Evening, or in Rain, &c. specially at the Beginning of Flowering, when the Seed is oung and tender; as is manifest in the Down of Dandelion, and other Downs; and eminently in the Flowers of Pimperel; the opening and shutting of which, are the Country-slan's Weather-wiser; whereby Gerard saith, he foretelleth that Weather shall follow the next Day; for, saith he, If see Flowers be close south up, it betokeneth Rain and soul Weather;

418 Flowers and Seed of Vegetables. BOOK X, like Guard, upon the Close and Cool of the Even.

ing, by Means of Rain, or other Matters that may

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be prejudicial to the tender Seed.

And now to these Considerations relating to the Seed, I might add the various Ways of Nature in dissipating and sowing it, some being for this end, winged with light Down, or Wings, to be conveyed about by the Winds; others being laid in elastick, springy Cases, that when they burst and crack, dart their Seed at convenient Distances, performing thereby the Part of a good Husbandman (p); others by their agreeable Taste and Smell.

contrarywise, if they be spread abroad, fair Weather. Ger. Herb. B. 2. c. 183.

Est & alia [arbor in Tylis] similis, folioser tamen, roseique sis; quem no au comprimens, aperire incipit Solis exertu, meridie espandit. Incola dormire eam dicunt. Plin. Nat. Hist. 1. 12. c. 11.

(p) So soon as the Seed is ripe, Nature taketh several Methods in its being duly Sown; not only in the opening of the Uterus, but allow the Make of the Seed it self. For, First, The Seeds of many Plant, which affett a peculiar Soil or Seat, as of Arum, Poppy, &c. m heavy and small enough, without farther Care, to fall directly down int the Ground ___But if they are so large and light, as to be exper'd n the Wind they are often furnifo'd with one or more Hooks, to stay then from straying too far from their proper Place ____ So the Seeds of Aven have one fingle Hook; those of Agrimony and Goosegrass, many; both the former loving a warm Bank; the latter, an Hedge for its Support. On the centrary, many Seeds are furnish'd with Wings " Feathers; partly with the Help of the Wind to carry them, when riv, from off the Plant, as of Ash, &c. - and partly to enable them h make their Flight more or less abread, that so they may not, by falling together, come up too thick; and that if one fould miss a good Soil " Bed, another may bit. So the Kernels of Pine bave Wings-yt foort—whereby they fly not into the Air, but only flutter upon the Ground. But these of Typha, Dandelion, and most of the pappour Kind—have long numerous Feathers, by which they are wasted. very Way .- Again, there are Seeds which are scatter'd not by flying abroad, but by being either spirted or flung away. The first of those are Wood-forrel, which baving a running Root, Nature fees fit to fow the Seeds at some Distance. The doing of subish is effected by a subite start Cover,

BOOK X. Flowers and Seed of Vegetables. 419

Cover, of a tendinous or springy Nature. This Cover, so soon as it begins to dry, bursts open on one Side, in an Instant, and is violently turn'd Inside outward—and so smartly throws off the Seed. The Seeds of Hart's-tongue, is slung or shot away—by the curious Contrivance of the Seed-case, as in Codded-Assmart, only there the Spring moves and curls inward, but here outward, viz. Every Seed-Case—is of a spherick Figure, and girded about with a sturdy spring.—The Surface of the Spring resembles a sine Skrew.—So soon as—this Spring is become stark enough, it suddenly breaks the Case into two Halfs, like two little Cups, and so slings the Seed. Grew, ih. p. 199. and in Tab. 72. all these admirable Artisces are handsomely represented.

Quin si quantitas modica seminum (Filicis Phyllitidis quoque) foliis in subjectam charta munda—schedam decutiatur, detergative, & deinde in acervum converratur, vesicularum seminalium plumis una dissilientibus, & sibi invicem allisis, acervulus varie moveri r partes videbitur; non secus ac si Syrenibus ant istiusmodi bestiolis pletus esset—quin si locus tranquillus sit, aure proxime admotas pitantium inter rumpendum vasculorum sonitus—percipietur; si microscopio chartam oculis oberres, semina per eam undique sparad notabilem ab acervò distantiam projetta comperies. Ray

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The admirable Contrivance of Nature, in this Plant is most plain. It the Seed-Vessels being the best Preserver of the Seed, 'tis there kept me the Injuries of Air and Earth, 'till it be rainy, when it is a pro-Time for it to grow, and then it is thrown round the Farth, as ain, by a skilful Sowet.——When any West touches the End of Seed-Vessels, with a smart Noise and sudden Leap it opens it self, with a Sring scatters its Seed to a pretty Distance round it, where rows. Dr. Sloane Voy. to Jamaica, p. 150. of the Gentilla store cornleo, &c. or Spirit-Leaf.

The Plants of the Cardamine-Family, and thany others, may added here, whose Cods fly open, and dart out their Seed, in a small Touch of the Hand. But the most remarkable tance is in the Cardamine impatiens, cujus Siliqua (saith Mr.) wel leviter tasta, astutum ejaculantur [Semina] imo, quod e mirabilius videtur, etsi siliquas non tetigeris, si tamen manum tasturus proxime admoveas, semina in approprinquantem evibra; quod tum Morisonus se sapirus expertum scribit, tum Johnstonus derardum verum esse affirmat, Hist. Plant. 1. 16. c. 20.

feither is this Provision made only for Land Vegetables, for such also as grow in the Sea. Of which I shall give instance from my before-commended Friend, Dr. Sloane. the Fuci,—their Seed hath been discover'd, (and show'd me) by the Industry of the ingenious Herbarist, Mr. Sam. Doody found on many of this Kind, solid Tubercules, or Risings in some Seasons;

420 Flowers and Seed of Vegetables. Book X.

Smell, and falutary Nature, inviting themselves to be swallow'd, and carry'd about by the Birds, and thereby also fertiliz'd by passing through their Bodies (q); and others not thus taken Care of, do

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Seasons, wherein were lodg'd several round Seeds, as hig as Mustard-Seed, which, when ripe, the outward Membrane of the Tubercule breaking, leaveth the Seed to float up and down with the Waves. The Seed coming near Stones, or any solid Foundation, by Means of a Muculage it carries with it, sticks to them, and shows forth Ligulæ with Branches, and in Time comes to its Perfection and Magnitude. Sloan

Voy. Jamica, p. 50.

But although Mr. Doody had hinted, and conjectur'd at the Thing; yet the first that discover'd the Seeds in Fuci, was the before-commended Dr. Tancred Robinson; as may be seen by comparing what Mr. Ray saith in his Synops. Stirp. Brit. p. 6. with his Append. Hist. p. 1849. Besides which Fuci, the Dr. tells me, he observed Vessels and Seed in Coralloid Shrubs, as also in several Fungi, not only in the Species of Crepitus Lupi, but also between the Lamella of other Species, and in that subterraneous Kind call'd Trusses, whose Seed and Vessels open in the Cortex, at some Seasons he saith, like that of Mallows in Shape.

As to the Crepitus Lupi, I have more than once examin'd their Powder, with those excellent Microscopes of Mr. Wilson's Make: But the most satisfactory View Mr. Wilson himself gave me; by which I found the Seeds to be so many exceeding small Puff-Balls, with round Heads, and longer than ordinary sharp-pointed Stalks, as if made on purpose to prick casily into the Ground. These Seeds are intermix'd with much dusty Matter, and become hurtful to the Eyes, probably by their sharp Stalks pricking and wounding

that tender Organ.

(9) The Ancient Naturalists do generally agree, that Misseltoe is propagated by its Seeds carried about by, and passing through the Body of Birds. Thus Theophrassus de Caus. Plant.
1. 2. c. 24. To g and our expression, &c. Initium verò à passum evium:— Quippe Visto detracto consectoque in alveis, quod frigidissimum est, semen cum excremento purum dimittitur, & sach mutatione aliqua in arbore Stercoris causa pubulat, erumpitque, &c. So also Pliny saith, viz. Omnino autem satum [Viscum] nuho modo nascitur, nec nist per alvum Avium redditum, maxime Pasumb's at Turdis. Hat est natura, ut nist maturatum in ventre Avium, 100 prove-

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Book X. Flowers and Seed of Vegetables. 42 I many of them by their Usefulness in Human Life, invite the Husbandman and Gardiner carefully to sow and nurse them up.

proveniat. Plin. N. H. l. 16. c. 44. Whether what Theophrassus and Pliny affirm, be conducive to the better fertilizing the Seeds of Misselve, I know not; but that it is not of ab olute Necessity, I can affirm upon mine own Experience, having seen the Seeds germinate, even in the Bark of Oak. But although they shot above an Inch, and seem'd to root in the Tree, yet they came to nothing, whether destroy'd by Ants, Ex. which I suspected, or whether disagreeing with the Oak, I know not. But I since find the Matter put out of doubt by Mr. Doody; which see in Mr. Ray's Hist. Plant, App. p. 1918.

Nutmegs are said to be fertiliz'd after the same Manner, as Tavernier saith was confirm'd to him by Persons that lived many Years in those Parts; whose Relation was: The Nutmeg being ripe, several Birds come from the Islands toward the South, and devour it whole, but are forced to throw it up again, before it be digested: And that the Nutmeg, then besmear'd with a viscous Matter, falling to the Ground, takes Root, and produces a Tree, which would never thrive, was it planted. Tavern. of the Conmod. of the G. Mogul. And Monsheur Theward, in his Travels to the Indies, gives this Account: The Tree is produc'd after this Manner; there is a Kind of Birds in the Island, that having pick'd off the green Husk, swallow the Nuts, which having been some Time in their Stomach, they void by the ordinary Way; and they fail not to take rooting in the Place where they fall, and in Time grow up to a Tree. This Bird is shap'd like a Cuckow; and the Dutch prohibit their Subjects, under Pain of Death, to kill any of them. Vide Sir T. Pope-Blum's Nat. Hist.

But Mr. Ray gives a somewhat different Account: Hunc fructum [Nucem Moschatam] varia quidem aves depascantur, sed maxime C. lumba genus album & parvum, qua debiscente nucamento, illesta suavitate Macis, bunc cum Nuce eripiunt & devorant, nec nist repletà ingluvie capacissimà saginam deserunt. Nostrates ibi mercatores Columbis istis Nut-eaters sive Nucivoris nomen imposuerunt. Quas autem vorant Nuces, post integras per alvum reddunt. Redditacitius deinde germinant utpote pramacerata servore Ventriculi. Arberes inde nata ceu praceciores, facile sunt corruptioni obnoxia fructumque ferunt cateris multo viliorem. & bac causa negletum incolis contemtumque, prater Macin, quem ad adulterandum meliorem adbibent,

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Ray H. P. 1, 27. c. 4.

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A22 Flowers and Seed of Vegetables. BOOK X.

To this so singular a Care about the Propagation and Conservation of the Species of Vegetables, I might add the nice Provision that is made for their Support and Aid, in standing and growing, that they may keep their Heads above Ground, and not be rotted and spoil'd in the Earth themselves, nor thereby annoy us; but on the contrary, minister to all their Ends, and our Uses; to afford us Houses, Utensils, Food (r), Physick, Cloathing, yea, Diversion too, by the Beauty of their Looks, by the Fragrancy of their Smell, by creating us pleasant Shades against the scorching Beams of Summer, and skreening us against the piercing Winds, and Cold of Winter (s). Bo

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P. 38

⁽r) Arbores blandieribus fruge succis hominem mitigavere. Ex iis recreans membra Olei liquor, viresque potus Vini; tot denique sapores annui sponte venientes: Emensa depugnetur licet e arum causa cum feri: Empasti naufragorum corporibus pisces expetantur, etiamnum tamen secunda: Mille praterea sunt usus earum, sine quibus vita degi non possit. Arbore sulcamus maria, terrasque admovemus, arbore exadissicamus testa. Plin. N. H. l. 12, c. 1.

⁽s) Plantarum Usus latissime patet, & in omni vita parte occurrit, Sine illis laute, fine illis commode non vivitur, at nec vivitur omnino: Quecunque ad victum necessaria sunt, quecunque ad delicias faciunt, e locupletissimo suo penu abunde subministrant. Quanto ex iis mensa innocentior, mundior, salubrior quam ex Animalium cade & laniena? Homo certe natura Animal carnivorum non est; nullis ad pradam of rapinam armis inftructum, non dentibus exertis & ferratis, non unquibus aduncis. Manus ad fructus colligendos, dentes ad mandendos comparati. Non legimus ei ante Diluvium carnes ad esum concessas. At von victum tantum nobis suppeditant, sed & Vestitum. & Medicinam & Domicilia aliaque adificia, & Navigia, & Supellettilem, & Foeum. & Oblectamenta Sensum Animique: Ex his naribus odoramenta & Suffumigia parantur. Horum flores inenarrabili colorum & Schematum varietate, & elegantia, oculos exhilarant, fuavissima odorum quos expirant fragantia spiritus recreant. Horum fructus gula illecebra mensas secundas instruunt, & languentem appetitum excitant. Taco eurorem amænissimum oculis amicum, quem per prata pascua agros, Sylvas Spatiantibus objiciunt, & umbras quas contra assum & solis ardores prebent. Ray ib, 1, 1, c, 24, p, 46, (1) All

⁽t)have neral being and E and u is to p a Var Space to for make if it l Natu ties o Infini them of the

BOOK X. Flowers and Seed of Vegetables. 423

And is is very observable what admirable Provisions are made for this Purpose of their Support and Standing, both in such as stand by their own Strength, and such as need the Help of others. In such as stand by their own Strength, it is by Means of the stronger and more ligneous Parts, (equivalent to the Bones in Animals,) being made not inflexible, as Bones; because they would then be apt to break; but of a yielding elastick Nature, to escape and dodge the Violence of the Winds; and by Means also of the Branches spreading hand-somely and commodiously about, at an Angle of about 45 gr. by which Means they equally fill up, and at the same Time make an Æquilibration of the Top (t).

And as for such Vegetables as are weak, and not able to support themselves, 'tis a wonderful Faculty they have, so readily and naturally to make Use of the Help of their Neighbours, embracing

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⁽t) All Vegetables of a tall and spreading Growth, seem to have a natural Tendency to an hemispherical Dilation, but generally confine their Spreading within an Angle of 90 gr. as being the most becoming and useful Disposition of its Parts and Branches. Now the shortest Way to give a most graceful and useful filling to that Space of dilating and spreading out, is to proceed in strait Lines, and to dispose of those Lines, in a Variety of Parallels, 80. And to do that in a quadrantal Space, &c. there appears but one Way possible, and that is, to form all the Interfections, which the Shoots and Branches make, with Angles of 45 gr. only. And I dare appeal to all, if it be not in this Manner, almost to a Nicety observ'd by Nature, &c. A visible Argument that the plastick Capacities of Matter are govern'd and dispos'd by an All-wise and Infinite Agent, the native Strictnesses and Regularities of them, plainly shewing from whose Hand they come. Account of the Origine and Format, of Fost. Shells, &c. Print. Lond. 1705. P. 38, 41,

424 Flowers and Seed of Vegetables. Book X. and climbing up upon them (u), and using them as Crutches to their feeble Bodies: Some by their odd convolving Faculty, by twifting themselves like a Screw about others; fome advancing themfelves, by catching and holding with their curious Claspers and Tendrels, equivalent to the Hands; fome by striking in their rooty Feet; and others by the Emission of a natural Glue, closely and firmly adhering to fomething or other that administers fufficient Support unto them. All which various Methods being fo nicely accommodated to the Indigencies

(u) In Hedera, surculi & rami kinc inde clavicules, quasi radiculas emittunt, que parietibus, vel occurrentibus arboribus veluti digitis firmantur. E in altum suspenduntur. Hujusmodi radicula subrotunda Junt, & pilis coperiuntur; & guod mirum est, glutinosum fundunt humorem, seu Terebinthinam, qua arcte lapidibus nectuntur & agglutinantur. - Non mineri industria Natura utitur in Vite Canadass, &c. The admirable and curious Make of whose Tendrels and their Feet, see in the illustrious Author, Malpig. de Ca-

preolis, &c. p. 48.

Claspers are of a Compound Nature, between that of a Root and a Trunk. Their Use is sometimes for Support only; as in the Claspers of Vines, Briony, &c. whose Branches being long, flender and fragile, would fall by their own Weight, and that of their Fruit; but these Claspers taking hold of any Thing that is at Hand; Which they do by a natural Circumvolution which they have; (those of Briony have a retrograde Motion about every third Circle, in the Form of a double Clasp; so that if they miss one Way, they may catch the other.) Sometimes the Use of Claspers is also for a Supply, as in the Trunk-Roots of Ivy; which being a Plant that mounts very high, and being of a closer and more compact Substance than that of Vines, the Sap would not be fuffciently supply'd to the upper Sprouts, unless these affished the Mother-Root; but these serve also for Support too. times also they serve for Stabiliment, Propagation and Shade; for the first of these serve the Claspers of Cucumers; for the fecond, those, or rather the Trunk-Roots of Chamomil; and for all Three the Trunk-Roots of Strawberries. Harris Lex. Tech, in verb, Claspers,

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In the last Place, to the Uses already hinted at, I might add a large Catalogue of such among Vegetables, as are of peculiar Use and Service to the World, and seem to be design'd as 'twere on Purpose, by the most Merciful Creator, for the Good of Man, or other Creatures (w). Among Grain, I might name the great Fertility (x) of such as serves for Bread, the easy Culture and Propagation thereof, and the Agreement of every Soil and Climate to it. Among Trees, and Plants, I might instance in some that seem to be design'd, as 'twere, on Purpose, for almost every Use (y),

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⁽w) Vegetables afford not only Food to Irrationals, but alfo Phyfick, if it be true which Ariffotle faith, and after him
Pliny; which latter in his 8th Book, Chap. 27. Specifies divers
Plants made use of as Specificks, by divers, both Beasts and
Birds: As Dittany by wounded Deer; Celandine by Swallows, to
cure the fore Eyes of their Young, &c. And if the Reader
hath a mind to see more Instances of this Nature, (many of
them fanciful enough,) he may consult Mersenne in Genes.
2, 932.

⁽x) See before, Book IV. Chap. 11. Note (b).

⁽y) Planta has unica [Aloe Americana] inquit Fr. Hernandez, quicquid vita esse potest necessarium prastave facile potest, si esset rebus humanis modus. Tota enim illa lignorum sepiendorumque agrorum usum prastat, caules tignorum, folia verò testa tegendi imbricum, lancium: eorundem nervuli, Essera eundem babent usum ad linteamina, calceos, Es vestimenta conficienda quem apud nos Linum, Cannabis, Gossipium, Esc. E mucronibus siunt clavi, aculei, subule, quibus personandis auribus, macerandi corporis gratia, Indis uti mos

426 Vegetables peculiarly Useful. BOOK X. and Convenience; some to heal the most stubborn and dangerous Distempers (2), to alleviate and case the Pains (aa) of our poor infirm Bodies, all the

erat cum Damonum vacarent cultui; item acicula, acus, tribuli mili. tares & raftilla idonea peBendis subtegminibus. Praterea è succe mananti, cujus evulfis germinibus internis feliifve tenerioribus culti [Yztlinis] in mediam cavitatem, stillat planta, unica ad 50 inter. dum amphoras (quod dietu oft mirabile) Vina, Mel, Acetum ac Sac. obarum parantur [The Methods of which he tells.] Iden fuccus menfes ciet, aloum lenit, Urinam evocat, Renes & Veftcam emundat. E radice quoque Reftes fiunt firmiffime. Craffiores folicrum partes, truntufque, decotta fub terra, edendo funt apta, fabi. untque Citrea frufta faccharo condita : quin & vulnera recentia mire conglutinant. Folia quoque affa & affetto loco imposta unoulfionem curant, ac dolores lemiunt (pracipue ft sucrus ipse calens bibatur) quamois ab Indica proficifcantur lue, fenfum bebetant, atque torporem inducunt. Radicis succus luem Veneream curat apud Indes ut Dr. Palmer. Ray. ibid. l. 21. c. 7. See also Dr. Sloans's Voyage to Jamaica, p. 247.

There also two Sorts of Aloe besides, mentioned by the fame Dr. Sleane, one of which is made use of for Fishing-Lines, Bow-Strings, Stockings, and Hammocks. Another hath Leaves that hold Rain-water, to which Travellers, & refort to quench their Thirst, in Scarcity of Wells, or Waters, in those dry Countries. Ibid. p. 249.

(z) For Instance here, I shall name the Cortex Peruvianni, which Dr. Morton calls Antidotus in levamen arumnarum vita humana plarimarum divinitus consessa. De Febr. Exer. v. c. 3. li Sanitatem Gentium proculdubio à Deo O. M. conditus. Cujus gratia, Arbor vita, figua alia, jure merito appellari poteft. Id. ib. c. 7. Eheu! quot convitiis Herculea & divina bac Antidotus jastabatur? Ibid.

To this (if we may believe the Epbemer, German, Ann, 11, Obser. 74. and some other Authors) we may add Trifolium Paludosum, which is become the Panacea of the German and

Northern Nations.

(aa) Pro doloribus quibuscunque sedandis prastantissimi sempa usus Opium babetur; quamobrem merito Nepenthe appellari sold, Fremedium vere divinum exiftit. Et quidem fatis mirari vix pf fumus, quomodo urgente visceris aut membri enjuspiam tortura insigni F intolerabili cruciatu, pharmacum boe, incantamenti inftar, leve men & avan notar subitam, imo interdum absque somne, aut sitem prins quam advenerit, concedit. Porro adbuc magis stupendun ef, quod dones particula Opiatica operari, & potentiam suam narcoli

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BOOK X. Vegetables peculiarly Useful. 427 World over: And some designed for the peculiar Service and Good of particular Places, either to cure such Distempers as are peculiar to them, by growing more plentifully there than elsewhere (bb); or else to obviate some Inconvenience there, or to supply some constant Necessity, or Occasion, not possible, or at least not easy, to be supplied any other Way (cc). It is, for Instance, an admirable

cam exerere continuant, imò etiam aliquamdiu postquam somnus sinitur, summa aleviatio, & indolentia in parte affettà persisti. Willis, Phar. rat. Par. 1. S. 7. cap. 1. sect. 15.

(bb) Tales Plantarum species in quacunque regione à Deo ereantur quales hominibus & animalibus ibidem natis maxime conveniunt; imò ex plantarum nascentium frequentià se fere animadvertere posse quibus morbis [endemiis] qualibet regio subjetta sit, scribit Solenander. Sic apud Danos, Frisios, Hollandos, quibus, Scorbutus frequents, Cochlearia copiose provenit. Ray. H. Pl. lib. 16. cap. 3.

To this may be added, Elfner's Observations concerning the Virtues of divers Things in his Observations de Vincetonica

Scrophularum remedio. F. Germ. T. 1. Obf. 57.

John Benorovinus, a Physician of Dort, may be here consulted, who wrote a Book on Purpose to shew, That every Country hath every Thing serving to its Occasions, and particular Remedies afforded to all the Distempers it is subject into. See Bener, 'Autagnesa, Batav, sive Introd, ad Medic.

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(c) The Description Dr. Sloane gives of the Wild-Pine is. That its Leaves are chanelled, fit to catch and convey Water down into their Reservatories; that these Reservatories are to made, as to hold much Water, and close at Top when all, to hinder its Evaporation; that these Plants grow on the Arms of the Trees in the Woods every where [in those Parts] as also on the Barks of their Trunks. And one Contivance of Nature in this Vegetable, (he faith,) is very admirable. The Seed hath long and many Threads of Tomenum, not only that it may be carried every where by the Vind—but also, that it may by those Threads, when drien through the Boughs, be held fast, and stick to the Arms, and extant Parts of the Barks of Trees. So soon as it Sprouter Germinates, although it be on the under Part of a Bough—its Leaves and Stalk rise perpendicular, or strait up.

428 Vegetables peculiarly Useful. BOOK X. ble Provision made for some Countries subject to Drought, that when the Waters every where fail, there are Vegetables which contain not only

Moisture enough to supply their own Vegetation and Wants, but afford Drink also both to Man and

other Creatures, in their great Extremities (dd);

because if it had any other Position, the Cistern (beforementioned, by which it is chiefly nourished ---) made of the hollow Leaves, could not hold Water, which is necessary for the Nourishment and Life of the Plant. In Scarcity of Water, this Reservatory is necessary and sufficient, not only for the Plant it felf, but likewise is very useful to Men, Birds, and all Sorts of Infects, whither they come in Troops, and feldom go away without Refreshment. Id. ib. p. 188. and Phil, Trans. No. 251, where a Figure is of this notable Plant, as also in Lowtherp's Abridg. Vol. 2. p. 669.

The Wild-Pine, so called, &c. hath Leaves that will hold Pint and a half, or Quart of Rain-Water; and this Water refreshes the Leaves, and nourishes the Root. When we find these Pines, we stick our Knives into the Leaves, just above the Root, and that lets out the Water, which we catch in our Hats, as I have done many Times to my great Relief. Dan-

pier's Voy. to Campeachy, c. 2. p. 56.

(dd) Navarette tells us of a Tree called the Bejuco, which twines about other Trees, with its End hanging downwards; and that Travellers cut the Nib off it, and prefently a Spout of Water runs out from it, as clear as Crystal, enough, and to spare, for fix or eight Men. I drank, (faith he,) to my Satisfaction of it, found it cool and fweet, and would drink it as often as I found it in my Way. It is a Juice and natural Water. It is the common Relief of the Herdsmen on the Mountains; when they are Thirsty, they lay hold on the Bi-juco, and drink their fill. Collect. of Voy. and Trav. Vol. 1. in the Suppl. to Navarette's Account of China, p. 355.

The Waterwith of Jamaica hath the same Uses, concerning which, my before-commended Friend, Dr. Sloane, favoured me with this Account from his Original Papers: This Vine growing on dry Hills, in the Woods, where no Water is to be met with, it Trunk, if cut into Pieces two or three Yards long, and held by either End to the Mouth, affords so plentifully a limpid, innocent, and to freshing Water, or Sap, as gives new Life to the droughty Travella or Hunter. Whence this is very much celebrated by all the Inhabitants

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BOOK X. Vegetables peculiarly Useful. 429 and a great deal more might be instanced in of a like Nature, and Things that bear such plain Impresses of the Divine Wisdom and Care, that they manifest the Super-intendence of the Insinite Creator.

Thus I have given a Sketch of another Branch of the Creation, which (although one of the meanest, yet) if it was accurately viewed, would abundantly manifest it self to be the Work of GOD. But because I have been so long upon the other Parts, although less than they deserve, I must therefore content my self with those general Hints I have given; which may however serve as Specimens of what might have been more largely said about this inferiour Part of the animated Creation.

As to the *Inanimate Part*, such as Stones, Minerals, Earth, and such-like, that which I have already said in the Beginning shall suffice.

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of these Islands, as an immediate Gift of Providence to their distrefsed Condition.

To this we may add what Mr. Ray takes Notice of concerning the Birch-Tree. In initiis Veris antequam folia prodiere, vulnerata dulcem succum copiose effundit, quem siti pressi Pastores in sylvis saponumero potare solent. Nos etiam non semel eo liquiore recreati sumus, cum berbarum gratia vassas peragravimus sylvas, inquit Tragus. Raii Cat. Plant. circa. Cantab. in Betula.



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BOOK XI.

Practical Inferences from the foregoing SURVEY.

Taying in the preceding BOOKS carried my Survey as far as I care at present to engage my self, all that remaineth, is to draw some Inferences from the foregoing Scene of the Great Creator's Works, and so conclude this Part of my intended Work.

CHAP. I.

That God's Works are Great and Excellent.

THE first Interence I shall make, shall be by way of Confirmation of the Text, That the Works of the Lord are great (a). And this is necessary to be observed, not against the Atheist only, but all other careless, incurious Observers of God's

⁽a) Equidem ne laudare quidem satis pro merito possum ejus Sapiontiam ac Potentiam, qui animalia fabricatus est. Nam ejusmodi opera non Laudibus modò, verùm etiam Hymnis sunt majora, qua priusquam inspexissemus, sieri non posse persuasum habeamus, conspicati verò, falsos vos opinione suisse somperimus. Galen. de Us. Part. l. 7. 6. 15.

God's Works. Many of our useful Labours, and fome of our best modern Books shall be condemned with only this Note of Reproach, That they are about trivial Matters (b), when in Truth they are ingenious and noble Discoveries of the Works of GOD. And how often will many own the World in General to be a Manifestation of the Infinite Creator, but look upon the feveral Parts thereof as only Toys and Trifles, scarce deserving their Regard? But in the foregoing (I may call it) transient View I have given of this lower, and most slighted Part of the Creation, I have, I hope, bundantly made out, that all the Works of the LORD, from the most regarded, admired, and braifed, to the meanest and most slighted, are Great and Glorious Works, incomparably contrived, and is admirably made, fitted up, and placed in the World. So far then are any of the Works of the LORD, (even those esteemed the meanest) from deserving to be disregarded, or contemned by us (c), that on the contrary they deserve (as shall be hewn in the next Chapter) to be fought out, enuired after, and curioufly, and diligently pryd into by us; as I have shewed the Word in the Text implies.

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im artem Natura exponunt: Eo enim modo omnino eam admiraren, sin minus, eam saltem non vituperarent. Galen. ibid. 1. 10.

⁽b) Non tamen pigere debet Lectores, ea inteligere, quemadmodum Naturam quidempiguit ea reipsa efficere. Galen. ibid. l. 11. fin. (c) An igitur etiamsi quemadmodum Natura hac, & ejusmodi, sumà ratione ac providentia agere potuis, ita & nos imitari aliquando semus? Ego vero existimo multis nostrum no id quidem posse, neque

CHAP. II.

That God's Works ought to be enquired into, and that such Enquiries are commendable.

HE Creator doubtless did not bestow so much Curiofity, and exquisite Workmanship and Skill upon his Greatures, to be looked upon with a careless, incurious Eye, especially to have them flighted or contemned; but to be admired by the rational Part of the World, to magnify his own Power, Wisdom and Goodness throughout all the World, and the Ages thereof. And therefore we may look upon it as a great Error, not to answer those Ends of the Infinite Creator, but rather to oppose and affront them. On the contrary, my Text commends GOD's Works, not only for being Great, but also approves of those curious and ingenious Enquirers, that feek them out, or pri into them. And the more we pry into, and dilcover of them, the Greater and more Glorious w find them to be, the more worthy of, and the more expresly to proclaim their Great Creator.

Commendable then are the Researches, which many amongst us have, of late Years, made into the Works of Nature, more than hath been done in some Ages before. And therefore when we are asked, Cui Bono? To what Purpose such Enquires such Pains, such Expence? The Answer is easy, is to answer the Ends for which GOD bestowed much Art, Wisdom and Power about them,

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Well as given us Senses to view and survey them; and an Understanding and Curiosity to search into them: It is to follow and trace Him, when and whither He leads us, that we may see and admire His Handy-work our selves, and set it forth to others, that they may see, admire, and praise it also. I shall then conclude this Inserence with what Elibu recommends, Fob xxxvi. 24, 25. Remember that thou magnify his Work, which Menbehold. Every Man may see it, Men may behold it afar off.

CHAP. III.

That God's Works are manifest to all: Whence the Unreasonableness of Insidelity.

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THE concluding Words of the preceding Chapter suggests a third Inserence, that the Works of GOD are so visible to all the World, and withal such manisest Indications of the Being, and Attributes of the Insinite Creator, that they plainly argue the Vileness and Perverseness of the Atheist, and leave him inexcusable. For it is a Sign a Man is a wilful, perverse Atheist, that will impute so Glorious a Work, as the Creation is, to any Thing, yea, a mere Nothing (as Chance is) rather than to GOD (a). It is a Sign the Man is wilfully blind, that

⁽a) Galen having taken Notice of the neat Distribution of the Nerves to the Muscles, and other Parts of the Face, cries out, Hac enim fortuna sunt opera! Caterum tum omnibus [partibus] mmitti, tantosque esse singulos [nervos] magnitudine, quanta particula trat necesse; haud scio an bominum sit sobriorum ad Fortunam opisicem

434 God's Works are manifest. Book XI. that he is under the Power of the Devil, under the Government of Prejudice, Luft, and Passion, not right Reason, that will not discern what every one can see, what every Man may behold afar off. even the Existence and Attributes of the CREATOR from his Works. For as there is no Speech or Language where their Voice is not heard, their Line is gone out through all the Earth, and their Words to the End of the World : So all. even the barbarous Nations, that never heard of GOD, have from these his Works interred the Existence of a Deity, and paid their Homages to some Deity, although they have been under great Mistakes in their Notions and Conclusions about Him. But however, this shews how naturally and univerfally all Mankind agree, in deducing their Belief of a God from the Contemplation of his Works, or as even Epicurus himself, in Tully(b) faith, from a Notion that Nature it felf hath imprinted upon the Minds of Men. For, faith he, what Nation is there, or what kind of Men, that

id revocare. Alioqui quid tandem erit, quod cum Providentia & Antefficitur? Omnino enim hoc ei contrarium esse debet, quod Casu ac Entuito sit. And afterwards, Hac quidem atque ejusmodi Artis sil, ac Sapientia opera esse dicemus, si modo Fortuna tribuenda sunt qui sunt contraria; sietque jam quod in proverbiis——Fluvii sursum suent; si opera qua nullum habent neque ornamentum neque ratium, neque modum Artis esse; contraria vero Fortuna duxerimus, & Galen. ubi supra. l. 11. c. 7.

(b) Primum esse Deos, quod in omnium animis, &c. And i little after, Cum enim non instituto aliquo, aut more, aut lege si opinio constituta, maneatque ad unum omnium sirma consensio, intellique necesse est, esse Deos, quoniam insitas eorum vel potius innatas consinones babemus. De quo autem omnium Natura consentit, id verm esse necesse est. Esse igitur Deos consitendum est. Cicer. de Nat Deor. l. 1. c. 16, 17.

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CHAP. III. God's Works are manifest. 435 that without any Teaching or Instructions, have not a kind of Anticipation, or pre-conceived Notion of a Deity?

An Atheist therefore (if ever there was any such) may justly be esteemed a Monster among Rational Beings; a Thing hard to be met with in the whole Tribe of Mankind; an Opposer of all the World (c); a Rebel against Human Nature and Reason;

as well as against his GOD.

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But above all, monstrous is this, or would be, in such as have heard of GOD, who have had the Benefit of the clear Gospel-Revelation. And still more monstrous this would be, in one Born and Baptized in the Christian Church, that hath studied Nature, and hath pried farther than others into God's Works. For such an one (if it be possible for such to be) to deny the Existence, or any of the Attributes of GOD, would be a great Argument of the Insinite Inconvenience of those Sins of Intemperance, Lust, and Riot, that have made he Man abandon his Reason, his Senses, yea, I had almost said his very Human Nature (d), to ngage him thus to deny the Being of GOD.

So also it is much the same monstrous Infidelity, t least betrays the same Atheistical Mind, to deny GOD's Providence, Care and Government of the Vorld, or (which is a Spawn of the same Epi-

curean

(d) See before, Note (b).

(e) Galen

⁽c) The Atheist in denying a God, doth, as Plutarch saith, deavour—immobilia movere, & bellum inferre non tantum go tempori, sed & multis hominibus, gentibus, & familiis, quas igiosus Deorum cultus, quasi divino survere correptas, tenuit. Plut. de Iside.

curean Principles) to deny Final Causes (e) in God's Works of Creation; or with the Profane, in Psal. lxxiii. 11. to say, How doth God know? And is there Knowledge in the most High? For as the witty and eloquent Salvian saith (f), They that affirm nothing is seen by GOD, will, in all Probability, take away the Substance, as well as Sight of God.——But what so great Madness, saith he, as that when a Man doth not deny GOD to be the Creator of all Things, he should deny him to be the Governour of them? Or when he confessed him to be the Maker, he should say, GOD neglecteth what he hath so made?

(e) Galen having substantially refuted the Epicurean Principles of Asclepiades, by shewing his Ignorance in Anatomy and Philosophy, and by demonstrating all the Causes to be evidently in the Works of Nature, viz. Final, Efficient, Instrumental Material, and Formal Causes, concludes thus against his fortuitous Atoms, ex quibus intelligi potest: Conditorem nostrum in sormal dis particulis unum bunc sequi scopum, numpe ut quod melius est elleut Galen. de Us. Part. 1, 6. c. 13.

(f) De Gubern. Dei. 1. 4. p. 124. mee Libro; alfo 1. 7.0. 14.

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CHAP. IV.

That God's Works ought to excite us to Fem and Obedience to God.

Since the Works of the Creation are all of the formany Demonstrations of the Infinite Wildow and Power of God, they may serve to us as so man Arguments exciting us to the constant Fear God, and to a steady, hearty Obedience to all Laws. And thus we may make these Works fervice

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CHAP. IV. Fear and Obedience God's Due. 437 ferviceable to our spiritual Interest, as they all are to our Life, and temporal Interest. For if whenever we fee them, we would confider that these are the Works of our Infinite Lord and Master, to whom we are to be accountable for all our Thoughts, Words and Works, and that in these we may see his Infinite Power and Wisdom; this would check us in Sinning, and excite us to serve and please Him, who is above all Controul, and who hath our Life and whole Happiness in his Power. After this Manner GOD himself argues with his own foolish People, and without Understanding, who bad Eyes, and faw not, and bad Ears, and beard not, Jer. v. 21, 22. Fear ye not me? faith the Lord: will ve not tremble at my Presence,

which have placed the Sand for the Bound of

the Sea, by a perpetual Decree, that it cannot

passit; and though the Waves thereof tost them-

felves, yet can they not prevail; though they

roar, yet can they not pass over it?

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This was an Argument that the most ignorant, stupid Wretches could not but apprehend; that a Being that had so vast and unruly an Element, as the Sea, absolutely at his Command, ought to be seared and obeyed; and that he ought to be considered as the Sovereign Lord of the World, on whom the World's Prosperity and Happiness did wholly depend; ver. 24. Neither say they in their Heart, let us now fear the Lord our God, that giveth Rain, both the former and the latter in his Season: He reserveth unto us the appointed

Weeks of the Harrest.

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CHAP. V.

That GOD's Works ought to excite us to Thankfulnefs.

A S the Demonstrations which GOD hath given of his Infinite Power and Wildom should excite us to Fear and Obedience; fo I shall shew in this Chapter, that the Demonstrations which he hath given of his Infinite Goodness in his Works. may excite us to due Thankfulness and Praise. It appears throughout the foregoing Survey, what Kindness GOD hath shewn to his Creatures in providing every Thing conducing to their Life, Prosperity and Happiness (a); how they are all contrived and made in the best Manner, placed in the fittest Places of the World for their Habitation and Comfort; accoutred in the best Manner, and accommodated with every, even all the minutest Things that may minister to their Health, Happinels,

⁽a) Si pauca quis tibi donâsset jugera, aecepisse te diceres benesicium: immensa terrarum late patentium spatia negas esse benesicium? Si pecuniam tibi aliquis donaverit—benesicium vocabis: tot metalla desolit, tot slumina emist in æra, super quæ decurrunt sola aurum ventia: argenti, cris, serri immane pondus omnibus locis obrutum, vejus investigandi tibi facultatem dedit,—negas te accepisse benesicium! Si domus tibi donetur, in qua marmoris aliquid resplendeat, &c. Num medioere munus vocabis? Ingens tibi domicilium, sine ullo incendii, au ruina metu struxit, in quo vides non tenues crustas—sed integraslapidis pretiossismi moles, &c. negas te ullum munus accepisse? Et cum ista qua babes magno astimes, quod est ingrati bominis, nulli debere i judicas? Unde tibi istum quem trabis spiritum? Unde istam, per quam dustus vita tua disponis atque ordinas, lucem? &c. Senec. de Benest. 1. 4. c. 6.

CHAP. V. Thankfulness is God's Due. 439 ness. Office. Occasions, and Business in the World.

Upon which Account, Thankfulness and Praise is so reasonable, so just a Debt to the Creator, that the Pfalmist calleth upon all the Creatures to praise God, in Psalm exlviii. Praise him all his Angels, Praise him all his Hosts; Sun, Moon, Stars of Light, Heavens of Heavens, and Il ters above the Heavens. The Reason give which is, ver. 5, 6. For be commanded, and they were created; he bath also established them for ever and ever; he hath made a Decree which they shall not pass. And not these Celestials alone, but the Creatures of the Earth and Waters too, even the Meteors, Fire and Hail, Snow and Vapours, stormy Winds fulfilling his Word. Yea, the very Mountains and Hills, Trees, Beasts, and all Cattle, creeping Things, and Hying Fowl. But in a particular Manner, all the Ranks and Orders, all the Ages and Sexes of Mankind are charged with this Duty; Let them praise he Name of the Lord, for his Name alone is excellent; his Glory is above the Earth and Heavens, ver. 13.

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And great Reason there is we should be excited to true and unseigned Thankfulness and Praise (1)

⁽b) Tempestivum tibi jam suerit, qui in bisce libris versaris considere, in utram Familiam recipi malis, Platonicamne ac Hipporaticam, & aliorum virorum, qui Natura opera mirantur; an corum ui ea insectantur, quod non per Pedes natura constituit essuere Excreenta. Of which having told a Story of an Acquaintance of its that blamed Nature on this Account, he then goes on, t verò si de hujusmodi pecudibus plura verba secero, melioris montis mines meritò mihi sorte succenseant, dioantque me possuere sacrum emonem, quem ego CONDITORIS nostri verum Hymnum comno, existimoque in co veram esse pietatem, ut si noverim ipse

440 Homage & Worship God's Due. Book XI. to this our Great Benefactor, if we reflect upon what hath been shewn in the preceding Survey, that the Creator hath done for Man alone, without any Regard to the rest of the Creatures, which some have held were made for the Sake of Man. Let us but reflect upon the Excellence and Immortality of our the incomparable Contrivance, and curious Structure of our Body; and the Care and Caution taken for the Security and Happiness of our State, and we fhail find, that among the whole Race of Beings, Man hath especial Reason to magnify the Creator's Goodness, and with suitable ardent Affections to be thankful unto him.

primus, deinde & aliis exposuerim, quanam sit ipsius Sapientia, que Virtus, qua Bonitas. Quod enim cultu conveniente exornaverit omnia. nullique hona inviderit, id perfectissima Bonitatis specimen esse statuo: & bac quidem ratione ejus Bonitas Hymnis nobis est celebranda. Hoc autem omne invenisse quo patto omnia potissimum adornarentur, summa Sapientia eft : effecisse autem bmnia, que voluit, Virtutis eft invitta. Galen. de Uf. Part. 1. 3. c. 10.

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CHAP. VI.

That we ought to pay God all due Homage, and Worship, particularly that of the Lord's Day.

FOR a Conclusion of these Lectures, the last Thing I shall infer, from the foregoing Demonstration of the Being and Attributes of GOD, shall be, that we ought to pay GOD all that Homage and Worship which his Right of Creation and Dominion entitle him unto, and his Great Mercies call for from us. And forafmuch as the Creator appointed, from the very Creation, one Day " leven

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CHAP. VI. Antiquity of the Sabbath. 441 feven to his Service, it will not therefore be improper to fay fomething upon that Subject: And if I insift somewhat particularly and largely thereon, the Congruity thereof to the Design of these Lectures, and the foregoing Demonstration, together with the too great Inadvertency about, and Neglect of this Ancient, Universal, and most Reasonable and Necessary Duty, will, I hope, plead my Excuse. But that I may say no more than is necessary on this Point, I shall consine my self to two Things; the Time God hath taken, and the Business then to be performed.

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I. The Time is one Day in seven, and one of the Ancientest Appointments it is which GOD gave to the World. For as soon as GOD had sinished his six Days Works of Creation, it is said, Gen. ii. 2, 3. He rested on the seventh Day from all his Work which he had made. And GOD blessed the seventh Day, and sanctified it, because that in it he had rested from all his Work. This Sanctification (a), and Blessing the Seventh Day, was setting it apart, as a Day of Distinction from the rest of the Week-Days, and appropriating it to Holy Uses and Purposes, namely, the Commemoration of that Great Work of the Creation, and paying Homage and Worship to that Infinite Being, who was the Essector of it.

This Day, thus confecrated from the Beginning, for the Celebration of the vi rious yerious the World's Birth-Day, as Philo calls it, was pro-

⁽a) WTP Usibus divinis accommodavit, à communi & profane su segrégavit, in usum sacrum ad cultum Dei destinavit. Kirch. Concord. p. 1336. Destinari ad aliquid, Sacrari, &c. Buxtors. in Verbo.

bably in some Measure forgotten in the following wicked Ages, which God complains of, Gen. vi. 5. and so after the Flood likewise. But after the Return out of Ægypt, when GOD settled the Fewish Polity, he was pleased to renew this Day, and to establish it for a perpetual standing Law. And accordingly it was observed down to our Blessed Saviour's Time, countenanced, and strictly observed by our Great LORD and Master himself, and his Apostles and Disciples in, and after his Time; and although for good Reasons the Day was changed by them, yet a Seventh Day hath been constantly observed in all Ages of Christianity, down to our present Time.

Thus we have a Day appointed by GOD himfelf, and observed throughout all Ages, except some few perhaps, which deserve not to be brought

into Example.

And a wife Defignation of Time this is, well becoming the Divine Care and Precaution; ferving for the recruiting our Bodies, and dispatching our Affairs, and at the same Time to keep up a Spiritual Temper of Mind. For by allowing fix Days to Labour, the Poor hath Time to earn his Bread, the Man of Business Time to dispatch his Affairs, and every Man Time for the Work of his respective Calling. But had there been more, or all our Time allotted to Labour and Business, and none to rest and recruit, our Bodies and Spirits would have been too much fatigued and wasted, and our Minds have been too long engaged about worldly Matters, fo as to have forgotten Divine Things. But the Infinitely Wife Ruler of the World, having takenthe Seventh Part of our Time to his own Service, hath

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CH.VI. Aseventb Day a wife Appointment. 443 prevented thele Inconveniencies; hath given a Relaxation to our felves; and Ease and Refreshment to our wearied Beafts, to poor fatigued Slaves, and fuch as are under the Bondage of Avaritious, Cruel And this is one Reason Moses gives of Masters. the Reservation and Rest on the Seventh Day, Deut. v. 13, 14, 15. Six Days Shalt thou labour, and do all thy Work; but the Seventh is the Sabbath of the LORD thy GOD; in it thou shalt not do any Work, thou, nor thy Children, Servants, Cattel, or Stranger, that thy Man-Servant and Maid-Servant may rest as well as thou. And remember, that thou wast a Servant, &c. therefore the LORD thy GOD commanded thee to keep the Sabbath Day. carnal, greedy People, so bent upon Gain, without such a Precept, would have scarce favoured their own Bodies, much less have had Mercy upon their poor Bondsmen and Beasts; but by this Wise Provision, this great Burden was taken off. But on the other Hand, as a longer Liberty would too much have robbed the Master's Time, and bred Idleness, so by this Wise Provision, of only one Day of Rest, to six of Labour, that Inconvenience was also prevented.

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Thus the Wise Governour of the World, hath taken Care for the Dispatch of Business. But then as too long Engagement about worldly Matters, would take off Mens Minds from God and Divine Matters; so by this Reservation of every Seventh Day, that great Inconvenience is prevented also; all being then bound to Worship their Great Lord and Master, to pay their Homages, and Acknowledgments to their infinitely kind Benefactor; and in a

Word,

444 Lord's Day must be remember'd. Book XI.

Word, to exercise themselves in Divine, Religious Business, and so keep up that spiritual Temper of Mind, that a perpetual, or too long Application to the World would destroy.

This, as it was a good Reason for the Order of a Sabbath to the Fews; so is as good a Reason for our Saviour's Continuance of the like Time in

the Christian Church.

And a Law this is, become the Infinitely Wife Creator and Confervator of the World; a Law, not only of great Use to the Perpetuating the Remembrance of those greatest of God's Mercies then commemorated, but also exactly adapted to the Life, Occasions, and State of Man; of Man living in this, and a-kin to another World: A Law well calculated to the Dispatch of our Affairs, without hurting our Bodies or Minds. And since the Law is so wise and good, we have great Reason then to practise carefully the Duties incumbent upon us; which will fall under the Consideration of the

II. Thing I proposed, the Business of the Day, which God hath reserved to himself. And there are two Things enjoyned in the Commandment, a Cossation from Labour and worldly Business; and that we remember to keep the Day Holy.

1. There must be a Cessation from worldly Bufiness, or a Rest from Labour, as the Word Sabbath (b) signifies. Six Days thou shalt do all thy Work, but the Seventh is the Sabbath of the Lord thy GOD [not thy Day but his] in which weither thou, nor any belonging to thee, shall do any Work. In which Injunction it is observable, ho

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⁽b) naw Ceffatio, Requies.

CH. IV. Lord's Day must be remember'd. 445 how express and particular this Commandment is, more than others, in ordering all Sorts of Persons to cease from Work.

Which Remembrance is another Thing also in this, more than in the other Commandments, and

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neglecting, or being hindred from keeping the Day Holy, either by the Infirmity and Carnality of our own Nature, or from the Avocations of the World.

adly, That the keeping it Holy, is a Duty of more than ordinary Consequence and Necessity.

And of greatest Consequence this is,

First, To perpetuate the Remembrance of those grand Works of GOD commemorated on that Day; in the first Ages of the World, the Creation; in the middle Ages, the Creation and Delivery from Ægypt; and under Christianity, the Creation and Redemption by Christ. Which Mercies, without such frequent Occasions, would be ready to be forgotten, or disregarded, in so long a Tract of Time, as the World hath already stood, and may, by God's Mercy still stand.

Secondly, To keep up a Spiritual Tempe rof Mind, by those frequent weekly Exercises of Re-

ligion, as hath been already mention'd.

Thirdly, To procure GOD's Bleffing upon the Labours and Business of our six Days, which we can never expect should be prosperous, if we are negligent of GOD's Time. For how can we expect GOD's Blefsing upon a Week so ill begun, with a Neglect, or Abuse of GOD's first Day? And there-

therefore if we become unprosperous in the World; if Losses, Troubles, or Dangers befall us, let us reflect how we have spent the Lord's Day; whether we have not wholly neglected it, or abused it in Riot, or made it a Day for taking Journeys, for more private Business, and less scandalous Labour,

as the Custom of too many is.

Thus having shewn what Reason there is to remember to keep Holy the Day dedicated to GOD. I shall consider how we are to keep it Holy, and fo conclude. Now the Way to keep it Holy, is not by bare resting from Work; for that, as a Father faith, is Sabbatum Boum & Asinorum, a Sabbath of Beafts: But Holy Acts are the proper Business for an Holy Day, celebrated by Rational Beings. Among all which, the grand, principal, and most universally practis'd, is the Publick Worship of GOD, the affembling at the Publick Place of his Worship, to pay (with our Fellow-Creatures) our Homages, Thanks, and Praises to the Infinite Creator and Redeemer of the World. This as it is the most reasonable Service, and proper Business for this Day, so is what hath been the Practice of all Ages. It was as early as Cain and Abel's Days, Gen. iv. 3. what was practis'd by Religious Persons in the following Ages, till the giving of the Law; and at the giving of That, God was pleas'd to order Places, and his particular Worship, as well as the Seventh Day. The Tabernacle and Temple were appointed by God's express Command; besides which, there were Synagogues all over the Nation; so that in our Saviour's Time, every great Town, Toru

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CH.VI. Publick Worship not indifferent. 447 Town, or Village, had one, or more in it, and Fe-

rusalem 460, or more (c).

The Worship of these Places, our Blessed SA-VIOUR was a constant and diligent Frequenter of. It is said, He went about all the Cities and Villages, Teaching in their Synagogues, and Preaching, and Healing, &c. Mat. ix. 35. And St. Luke reporteth it as his constant Custom or Practice, Luke iv. 16. And as his Custom was, he went into the Synagogue on the Sab-

bath-Day.

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Having thus mention'd the Practice of CHRIST. it is not necessary I should say much of the Practice of his Apostles, and the following purer Ages of Christianity, who, in short, as their Duty was, diligently follow'd their Great Master's Example. They did not think it enough to read and pray, and praise God at Home, but made Conscience of appearing in the Publick Assemblies, from which nothing but Sickness and absolute Necessity did detain them; and if Sick, or in Pricon, or under Banishment, nothing troubled them nore, than that they could not come to Church. and join their Devotions to the Common Servi-If Persecution at any Time forc'd them to keep a little Close; yet no sooner was there the least Mitigation, but they presently returned to their open Duty, and publickly met all together. No trivial Pretences, no light Exruses were then admitted for any ones Absence from the Congregation, but according to the Merit of the Cause, severe Censures were pass'd

⁽c) See Lightfoot's Works, Vol. 2. p. 35, and 646.

448 Profanation of the Sabbath, &c BOOKXI.

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upon them, &c. to express it in the Words of one

of our best Antiquaries (d).

The Publick Worship of GOD then, is not a Matter of Indifference, which Men have in their own Power to do, or omit as they please; neither is it enough to read, pray, or praise God at Home. (unless some inevitable Necessity hindereth;) because the appearing in GOD's House, on his Day, is an Act of Homage and Fealty, due to the CRE. ATOR, a Right of Sovereignty we pay him. And the with-holding those Rights and Dues from GOD, is a kind of rejecting GOD, a disowning his Sovereignty, and a with-drawing our Obedience and Service. And this was the very Reason why the Profanation of the Sabbath was punish'd with Death among the Fews, the Sabbath being a Sign, or Badge of the GOD they own'd and worshipp'd (e). Thus Exod. xxxi. 13. My Sab.

(d) Dr. Cave's Primitive Christianity, Par. 1. cap. 7.

⁽e) At this Day it is cuftomary for Servants to wear the Livery of their Masters, and others to bear Badges of their Order, Profession, Servility, &c. So in former Ages, and divers Countries, it was usual to bear Badges, Marks and Signs on divers Occasions. In Ezek. ix. 4. A Mark was to he fet on the Forehead of those that lamented the Abominations of the City. The like was to be done upon them in Rev. vii. 3. and is 4. So the Worshippers of the Beast, Rev. xiii. 16. were w receive a xaegyua, A Mark in their right Hand, on their Fort Those xees puala, Eogay is so, Badges, &c. were ver common. Soldiers and Slaves bear them in their Arms of Poreheads; fuch as were matriculated in the Heteria, of Companies, bear the Badge or Mark of their Company and whoever listed himself into the Society of any of the feveral Gode, received a xagyua, or a Mark in his Body (commonly made with red-hot Needles, or some burning if the Flesh,) of the God he had listed himself under. An

CH. VI. Profanation of the Sabbath, &c. 449 baths ye shall keep; for it is a SIGN between me and you, throughout your Generations; that ye may know that I am the LORD, that doth santify you; or as the Original may be render'd, A Sign to acknowledge, that I Jehovah am your Santifier, or your God: For as our learned Mede observes, To be the Santifier of a People, and to be their God, is all one. So likewise very expressly in Ezek. xx. 20. Hallow my Sabbaths, and they shall be a Sign between me and you, that ye may know that I am the LORD your GOD; or rather as before, to acknowledge that I JEHOVAH am your GOD.

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The Sabbath being thus a Sign, a Mark, or Badge, to acknowledge God to be their God, it follows, that a Neglect or Contempt of that Day, redounded to GOD; to flight that, was flighting God; to profane that, was to affront God; for the Punishment of which, What more equitable Penalty than Death? And although unler Christianity, the Punishment is not made Capital, yet have we no less Reason for the strict

fter Christianity was planted, the Christians had also their sign of the Cross. And not only Marks in their Flesh, Badges on their Cloaths, &c. were usual; but also the Dedication of Days to their imaginary Deities. Not to speak of their Fedivals, &c. the Days of the Week were all dedicated to some of their Deities. Among the Romans, Sunday and Monday, the Sun and Moon; Tuesday to Mars; Wednesday to Merwy, &c. So our Saxon Ancestors did the same; Sunday and Aonday, (as the Romans did,) to the Sun and Moon; Tuesday to Tuysco; Wednesday to Woden; Thursday to Thor; Friday of Friga; and Saturday to Seater: An Account of which Deies, with the Figures under which they were worshipp'd, way be met with in our learned Verstegan, Chap. 3.7.68.

450 Necessity of Publick Worship. Book XI. Observance of this Holy Day, than the Fews, but rather greater Reasons. For the GOD we wor. ship, is the same: If after Six Days Labour, He was, by the Seventh, own'd to be GOD, the Creator; no less is He by our Christian Lord's Day: If by the Celebration of the Sabbath, the Remembrance of their Deliverance from the A. gyptian Bondage was kept up, and GOD acknowledged to be the Effector thereof; we Christians have a greater Deliverance, we own our Deliverance from Sin and Satan, wrought by a greater Redeemer than Moses, even the Bleffed Jesus, whose Resurrection, and the Completion of our Redemption thereby, was perform'd on the

Christian Lord's-Day. And now to fum up, and conclude these Infetences, and so put an End to this Part of my Survey: Since it appears, that the Works of the LORD are fo Great, fo Wifely Contriv'd, fo Accurately Made, as to deserve to be enquir'd into; fince they are also so manifest Demonstrations of the Creator's Being and Attributes, that all the World is fensible thereof, to the Great Reproach of Atheism: What remaineth? But that we fear and obey fo Great and Tremendous a Being; that we be truly thankful for, and magnifie and praise his Infinite Mercy, manifested to us in his Works. And forafmuch as He hath appointed a Day on Purpose, from the Beginning, for these Services, that we may weekly meet together, commemorate and celebrate the Great Work of Creation; that we may pay our Acts of Devotion, Worship, Homage and Fealty to Him; and fince this is a Wise and Excellent Distribution of our Time,

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CHAP. VI. The Conclusion.

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What should we do, but conscientiously and faithfully pay GOD these his Rights and Dues? And as carefully and diligently manage GOD's Time and Discharge his Business then, as we do our own upon our six Days; particularly that with the pious Psalmist, We love the Habitation of God's House, and the Place where his Honour dwelleth; and therefore take up his good Resolution in Psal. ver. 7. with which I shall conclude; But as for me, I will come into thine House in the Multitude of thy Mercy, and in thy Fear will I worship towards thy holy Temple.

Now to the same Infinite GOD, the Omnipotent Creator and Preserver of the World, the most Gracious Redeemer, Sanctifier, and Inspirer of Mankind, be all Honour, Praise and Thanks, now

and ever. Amen.

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